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Editorial

Hotspots and Coldspots

In 1988, the celebrated British ecologist Norman Myers gave the concept of biodiversity hotspots as a method to identify most important areas for conservation (Myers 1988). This concept was later expanded and criteria for identifying hotspots were developed – the region must support at least 1,500 plant species found nowhere else in the world, and it must have lost at least 70 per cent of its original vegetation. It was suggested that if we protect the biodiversity hotspots of the world, nearly 30-50% of the world's biodiversity would be protected (Myers 1990; Myers *et al.* 2000). Hotspots are areas with very rich biodiversity such as the tropical rain forests of Brazil, Indonesia, northeast India and the Western Ghats. There are supposed to be 12 mega-diversity countries in the world, and India is one of them. 30-50% of amphibian, reptile, mammal, bird and plant species occur in 25 hotspots that occupy about 2% of the land surface (except the ice-covered polar regions) (Myer *et al.* 2000). Conservationists and funding agencies, looking for easy solutions to the biodiversity crises of the world fell for the hotspot conservation concept. Who would not? By protecting less than 2% of the land's surface, if we can save 30 to 50% of the species, then we should accept the hotspot model of conservation. But what about the habitats (and the species) that do not qualify the hotspot criteria? What about the 50-70% species that do not occur in the hotspots? Are they less important? Do they also not play their role in maintaining the life support system of this world? Do they not have endemic and rare species that need protecting? Are these areas not important culturally, spiritually, economically and scenically? Shouldn't we have a taxa or habitat representative and ecoregion approach for global biodiversity conservation? The whole concept of biodiversity hotspot conservation approach has been questioned recently (Smith *et al.* 2001; Kareiva and Marvier 2003; Entwistle 2004).

The high altitude cold deserts of India, China, Central Asia and South America, the wind-swept grasslands of Mongolia, the hot deserts of Asia, the Middle East, northern Africa and North America, the boreal forest of Europe, the scrub forest of India – all these may not have high species diversity and would not fall in the hotspot category, but these ecosystems are also important for conservation initiative and funding. We can call them biodiversity 'coldspots'. As desert and grassland species are generally thinly and widely distributed, they need a landscape approach for conservation. Moreover, millions of people live in these ecosystems and have great impact on the ecology and distribution of wild animals, thus conservation actions become much more complex. In the hotspot conservation paradigm, we can set aside human free, relatively small protected areas (PAs) and save huge numbers of endemic and rare species, but in the coldspots, a different conservation approach is needed. Here the small PAs (about 500 to 1000 sq. km) would not make much conservation sense as the genetically viable populations of any target species range in much larger areas (e.g. Great Indian Bustard *Ardeotis nigriceps*, Snow Leopard *Uncia uncia*, Wolf *Canis lupus*). Therefore, in deserts, grasslands and marine ecosystems we need thousands of sq. km of protected areas. Can Man be excluded from such large PAs?

The IUCN Red List of 2004 includes an assessment for 38,047 species. The results are shocking: 15,589 species are threatened with extinction (listed as Critically Endangered, Endangered or Vulnerable); 844 species are Extinct or Extinct in the Wild; 3,700 species are listed as Near Threatened or Conservation Dependent; 3,580 are Data Deficient; and, 14,344 are Least Concern (Baillie *et al.* 2004). The 15,589 species threatened with extinction constitute only 1% of the world's described species. Although statistics of how many of these threatened species are found in the world's hotspots is not available to me, a quick glance at the bird list shows that for many species, especially those found in marine, temperate forest, desert and grassland, the hotspot model of conservation priority setting would not be adequate. BirdLife International's Important Bird Areas (IBAs) (Grimmett and Jones 1989) and Endemic Bird Areas (EBAs) (Stattersfield *et al.* 1998) approaches are very objective in identifying sites for conservation. It has been found that many sites important for birds are also important for other biodiversity. In the IBA/EBA process, the biodiversity hotspots are invariably identified as IBAs/EBAs, but scrubland, grasslands,

mangroves, taiga, boreal forests etc., also found place in the IBA/EBA lists. Most endemic bird species are found in only one EBA (Norris and Harper 2004) and many EBAs do not fall in the hotspots category (of Myers *et al.* 2000). Norris and Harper (2004) have shown that out of the 39 ecologically vulnerable EBAs, 22 are not inside any hotspot region of Myers *et al.* (2000). They conclude that existing priority-setting exercises for hotspots of endemism under-represent ecologically vulnerable sites. Therefore, if we concentrate mainly on hotspot approach of conservation, some of the most threatened species and their habitat would be left out.

Olson *et al.* (2001) have identified 14 major biomes worldwide. In the assessment of the number of threatened mammals, birds and amphibians occurring in each biome (Baillie *et al.* 2004), the highest number of threatened species in all the three taxa were found in Tropical/Subtropical Moist Broadleaf Forest, and Tropical/Subtropical Dry Broadleaf Forest (the biodiversity hotspots). Surprisingly, the third and fourth biome categories having the highest number of threatened species were Tropical/Subtropical Grassland, Savanna and Shrubland, and Montane Grassland and Shrubland. Desert and Xeric Shrubland biome was high in the priority for mammals and birds, almost equal to Tropical/Subtropical Dry Broadleaf Forest biome (Baillie *et al.* 2004, p. 69).

The 'hotspots' conservation model is certainly very objective, but unfortunately it does not cover all the biodiversity priority conservation areas. A 'habitat-taxa representative' model is more subjective but it covers most, if not all, ecoregions of the world (Dinerstein *et al.* 1995; Ricketts *et al.* 1999; Wikramananyake *et al.* 2002). Perhaps we have to blend the two models in the conservation priority-setting exercises. It is time to accept that 'coldspots' are as important for biodiversity conservation as the hotspots.

Asad R. Rahmani

REFERENCES

Baillie, J.E M., C. Hilton-Taylor, S.N. Stuart (Eds) (2004): 2004 IUCN Red List of Threatened Species: A Global Species Assessment. IUCN, Gland, Switzerland and Cambridge, U.K.

Dinerstein, E., D.M. Olson, D. Graham, A. Webster, S. Primm, M. Bookbinder & G. Ledec (1995): A conservation assessment of the terrestrial ecoregions of Latin America and the Caribbean. World Bank, Washington, D.C. USA.

Entwistle, A. (2004): Eurasia – a biodiversity coldspot? *Oryx 38(3)*: 239-240.

Grimmett, R.F.A. & T.A. Jones (1989): Important Bird Areas in Europe. Tech. Publ. 9. International Council for Bird Preservation, Cambridge, U.K.

Kareiva, P. & M. Marvier (2003): Conserving biodiversity coldspots. *American Scientists 91*: 344-351.

Myers, N. (1988): Threatened biotas: "hotspots" in tropical forests. *The Environmentalist 8*: 187-208.

Myers, N. (1990): The biodiversity challenge: expanded hot-spot analysis. *The Environmentalist 10*: 243-256.

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. Fonseca & J. Kent (2000): Biodiversity hotspots for conservation priority. *Nature 403*: 280-283.

Norris, K. & N. Harper (2004): Extinction processes in hot spots of avian biodiversity and the targeting of pre-emptive conservation action. *Proc. R. Soc. Lond.* B: 271: 123-130.

Olson, D.M., E. Dinerstein, E.D. Wikramanayake, N.D. Burgess, G.V.N. Powell, E.C. Underwood, J.A. D'Amico, I. Itoua, H.E. Strand, J.C. Morrison, C.J. Loucks, T.F. Allnutt, T.H. Ricketts, Y. Kura, J.F. Lamoreux, W.W. Wettengel, P. Hedao & K.R. Kassem (2001): Terrestrial ecoregions of the world: a new map of life on Earth. *BioScience, 51*: 933-938.

Ricketts, T.H., E. Dinerstein, D.M. Olson, C.J. Loucks, W. Eichbaum, D. DellaSala, K. Kavanagh, P. Hedao, P.T. Hurley, K.M. Carney, R. Abell & S. Walters (1999): Terrestrial ecoregions of North America: A conservation assessment. Island Press, Washington D. C., USA.

Smith, T.B., S. Kark, C.J. Schneider, R.K. Wayne & C. Moritz (2001): Biodiversity hotspots and beyond: the need for preserving environmental transitions. *Trends in Ecology & Evolution 16 (8)*: 431.

Stattersfield, A.J., M.J. Crosby, A.J. Long & D.C. Wege (1998): Endemic Bird Areas of the World. BirdLife International, Cambridge, U.K.

Wikramanayake, E., E. Dinerstein, C.J. Loucks, D.M. Olson, J. Morrison, J. Lamoreux, M. McKnight & P. Hedao (2002): Terrestrial ecoregions of the Indo-Pacific: A conservation assessment. Island Press, Washington, D.C., USA.

DIETARY DIFFERENCES BETWEEN TWO GROUPS OF PHAYRE'S LANGUR *TRACHYPITHECUS PHAYREI* IN TRIPURA, INDIA: RESPONSES TO FOOD ABUNDANCE AND HUMAN DISTURBANCE[1]

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Dietary differences were compared between two groups of Phayre's Langur (*Trachypithecus phayrei*), one each in Gumti and Sepahijala Wildlife Sanctuary, Tripura, northeast India. In Gumti Wildlife Sanctuary (GWLS), out of 19 food species used by the group, just 5 accounted for more than 75% of the total feeding time, while in Sepahijala Wildlife Sanctuary (SWLS), 16 out of 67 food species accounted for almost the same feeding time. Out of twelve common food species in both the sanctuaries, some were used more frequently in GWLS than in SWLS, and *vice versa*, e.g. *Albizzia procera* was a highly preferred food species in Gumti than in Sepahijala. Feeding on young foliage was almost the same for both the groups. In GWLS, the langur ate more seeds (23.2%) and a little unripe fruit (5.3%), while in SWLS, it ate more unripe fruit (17.6%) and spent equal durations of time feeding on seeds (6.0%) and mature foliage (5.8%). Differences in food abundance and availability, and variations in the nature and intensity of human disturbance have been identified as some of the possible reasons for the dietary differences in the two groups. This study highlights the need for species- and area-specific conservation strategies, based on detailed information on specific ecological needs of adjacent populations of any given indicator/ flagship wildlife species.

Key words: Phayre's Langur, *Trachypithecus phayrei*, Tripura, feeding ecology, human disturbance, learnt cultural traditions

INTRODUCTION

Dietary differences among neighbouring populations of the same primate species could be more than simply a measure of the presence or absence of specific food items from their home ranges (Chapman and Fedigan 1990). Richards (1977) noted that one population of *Propithecus verreauxi* fed extensively on one specific food item, whereas another population totally ignored it, although the abundance of that item was almost same. Schlichte (1978) observed that differences in the feeding behaviour may be dependent not only on the density of the plant species, but also on the composition of the vegetation as a whole. Dietary differences have also been explained in terms of: environmental differences and/or primate cultural traditions (Kummer 1971; McGrew 1983, Richards 1985); human disturbance (Nishida *et al.* 1983); role of phytochemistry and secondary compounds in food selection (Freeland and Janzen 1974; Oates *et al.* 1977; Waterman and Choo 1981; Mowry *et al.* 1996); and food profitability in terms of nutrients, energy value and availability (Chapman and Fedigan 1990).

In this paper, I examine the dietary differences between two groups of Phayre's Langur (*Trachypithecus phayrei*), in relation to variations in food abundance; human disturbance and cultural traditions.

METHODS

Study animal

Phayre's Langur *Trachypithecus phayrei* (=*Presbytis phayrei*), belongs to Family Colobidae. Since the last review on the taxonomic status of this species by Agrawal (1974), confusion has persisted as it is referred to by different names: *Presbytis phayrei*, *P. barbei* and *Trachypithecus phayrei*. Gupta (1998) reviewed its taxonomic status and recommended the use of Phayre's Langur *Trachypithecus phayrei phayrei* as the common and scientific names for this species. The species is reported in Bangladesh, India, Myanmar, China, Thailand, Laos and Vietnam. The western and eastern limits of this species are Bangladesh (24° 30' N, 90° 10' E) and North Vietnam (20° 19' N, 105° 38' E) while its northern and southern limits are China (25° N, 98° 45' E) and Thailand (14° 41' N, 98° 52' E) respectively. In India, Tripura has the largest population (Gupta 1994) of this species, which was also reported from Assam (Choudhury 1986) and Mizoram (Mishra *et al.* unpublished report).

Study sites and Study groups

The study was conducted in Gumti (23° 21'-23° 40' N; 91° 57' E) and Sepahijala (23° 38'-23° 42' N; 91° 17'-91° 22' E) wildlife sanctuaries separated by about 100 km (Fig. 1).

Gumti Wildlife Sanctuary: Gumti (389.5 sq. km) receives annual rainfall of about 150 cm; its minimum and maximum temperatures are *c.* 4 °C and 38 °C respectively. Mean altitude varies between 150-380 m above msl. The study site was a secondary forest patch (68 ha) of about 15 years' regeneration growth, due to shifting cultivation (*jhum*), located at Mukhchheri, about 16 km from the Sanctuary headquarters at Jatanbari. *Jhum* was a major human disturbance. The forest types are Evergreen and Moist, Mixed Semi-Evergreen and

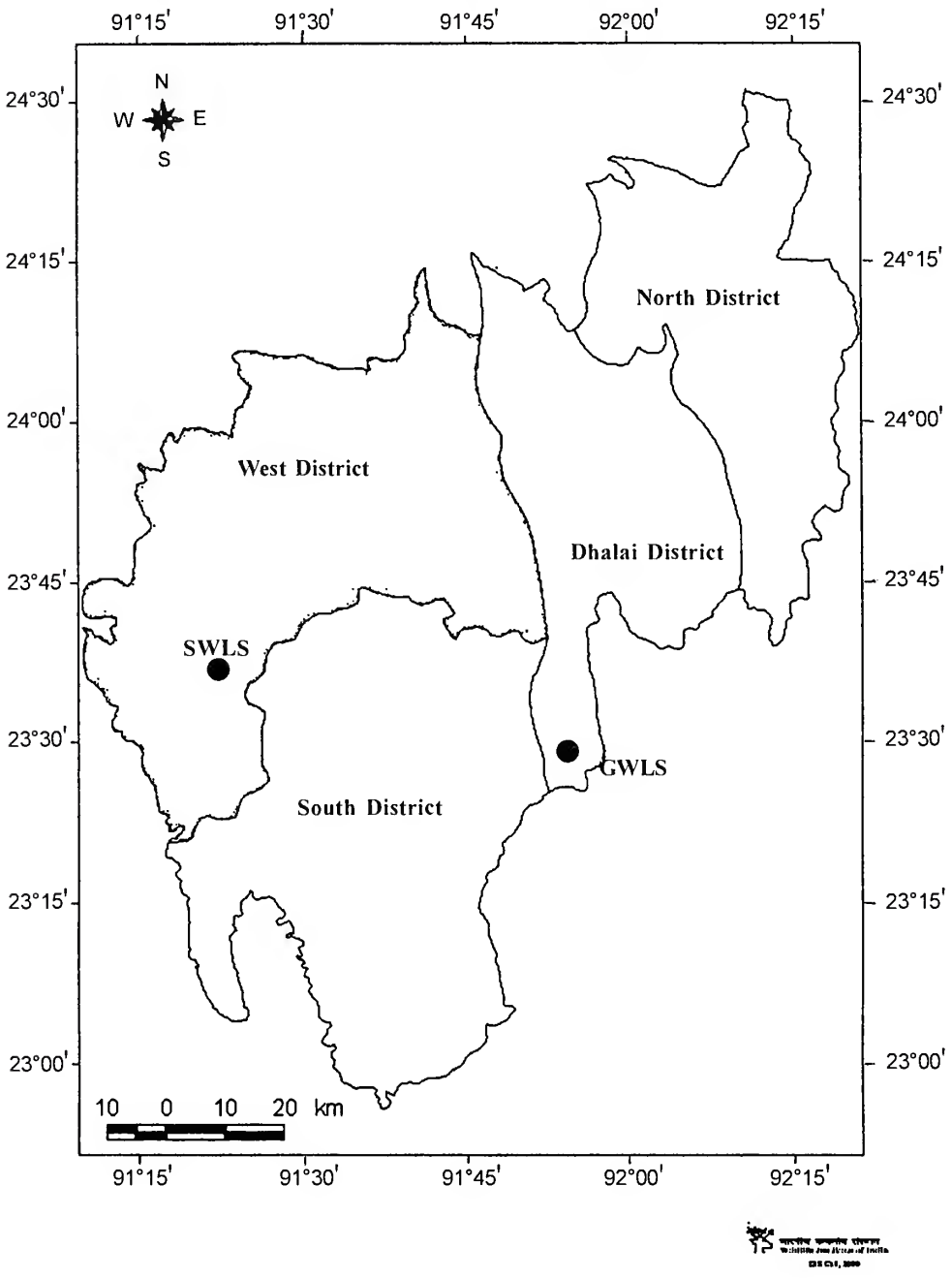

Fig. 1: Map of Tripura, northeast India, showing location of Gumti and Sepahijala Wildlife Sanctuaries

Deciduous. Main plant species included large stands of *Lagerstroemia parviflora*, *L. flos-reginae*, *Albizzia procera*, *A. stipulata*, *A. lebbek*, *Bursera serrata*, *Gmelina arborea*, *Eugenia jambolina*, *Salmalia malabarica*, besides bamboo (*Melocanna bambusoides*), thatch (*Imperata cylindrica*), *Mikania scandens*, *Holarrhena antidysentrica*, and *Eupatorium* sp. The middle and lower canopy was a coppice of fire-hardy secondary forest species. A total of 17 groups of Phayre's Langur were present in Gumti, of which five were within the study area. One of these was selected for an intensive ecological study. During the study period, this group (referred to as Group-G) consisted of 18 individuals: 1 adult male, 5 adult females, 9 sub-adults, 2 infants, and 1 new born. Other primate species in the study area were: Capped Langur (*Trachypithecus pileatus*), Hoolock Gibbon (*Hylobates hoolock*), Slow Loris (*Nycticebus coucang*), Rhesus Macaque (*Macaca mulatta*), Stump-tailed Macaque (*M. arctoides*) and Pig-tailed Macaque (*M. nemestrina*).

Sepahijala Wildlife Sanctuary: The annual rainfall (120 cm) of Sepahijala Wildlife Sanctuary (18.5 sq. km) is less than Gumti WLS, but its minimum and maximum range of temperatures are similar to Gumti. Mean altitude varies between 20-40 m above msl. The study area is a Reserved Forest (69 ha) consisting mainly of Semi-evergreen forest: *Terminalia belerica*, *T. chebula*, *Gmelina arborea*, *Albizzia stipulata*, *Dillenia pentagyna*, *Ficus racemosa*, *F. fistulosa*, *F. hispida*, *Syzygium fruticosum*, *Artocarpus chaplasha*, *Salmalia malabarica*, and *Schima wallichii* among others. It was noted that *Ficus* trees were well represented, mainly because *jhum* was almost absent in this area.

The study area here differed from Gumti in the presence of forestry plantation patches. These plantations (about 9 ha) of native and exotic tree species (*Tectona grandis*, *Acacia auriculiformis*, *Adenanthera pavonina*, *Delonix regia*, *Hevea braziliensis*, were raised in the early 1980s to restore the forest which had been degraded due to heavy biotic pressure (largely for collection of forest products, livestock grazing and cultivation) from 17 villages located in and around this area.

The food plant species diversity used by the langurs here is 41 species/ha (almost twice than at GWLS) although estimated tree density is marginally less at 250 trees/ha (Gupta 1996).

Sepahijala had 17 groups of Phayre's Langur, of which four were within the study area. The study group (Group-S) consisted of 7 individuals (1 adult male, 3 adult females, 1 sub-adult and 2 infants) at the beginning of the study, which increased to 11 individuals (3 adult males, 3 adult females, 1 sub-adult, 2 infants and 2 new born) at the end of the study period following immigration and new births. Other primate species in the area were Capped Langur, Rhesus Macaque, Pig-tailed Macaque and Slow Loris. One group of Golden Langur (*Trachypithecus geei*) introduced in this Sanctuary was also present (Gupta and Mukherjee 1994). Hoolock Gibbon and Stump-tailed Macaque were absent.

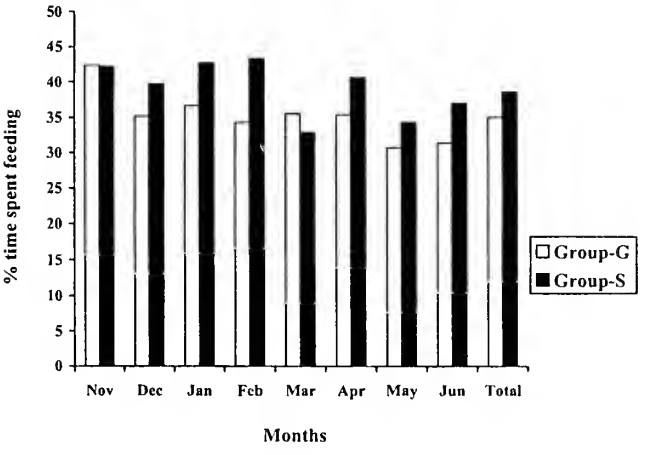

Fig. 2: Percent time spent feeding by Group-G and Group-S of Phayre's langur (*Trachypithecus phayrei*) in Gumti and Sepahijala Wildlife Sanctuary

Ecological and behavioural observations

Ecological and behavioural data on Group-G were collected for seven months from November 1989 to June 1990. Data on Group-S were collected for one complete year from November 1993 to October 1994, but only 8 months (Nov.-Jun) data have been used in this paper.

An initial period of about three months was spent surveying, mapping and habituating the selected study animal groups before undertaking intensive studies at both sites.

Vegetation Sampling

In Gumti WLS, trees ≥ 20 cm girth at breast height (gbh) were enumerated from 10 random sample plots, each 50 x 50 m, covering about 9% of home range of the study group (27.8 ha). In Sepahijala WLS, 12 strip transects were randomly laid within the home range of Group-S covering about 62% of the home range (20.3 ha). The width of each strip was fixed at 40 m while the length varied between 75 m and 525 m.

The group-scan method (Altmann 1974) was used at both sites to collect data on dietary patterns and other activities. The study group was scanned for 5 consecutive days in each month and an interval of 15 minutes was maintained between two consecutive scans. A total of 14,186 and 15,818 records were made in eight months in Gumti WLS and Sepahijala WLS, respectively. Percent time spent feeding was estimated from: $T = (n_f \times 100)/N$, where T = % daytime spent feeding, n_f = number of records that included feeding, and N = total number of records for the day.

RESULTS

Group-G spent 34.9% (range = 30.6-42.2%) and Group-S spent 38.5% (range = 32.7-42.6%) of the total activity time feeding (Fig. 2). There was significant difference between both the groups in the feeding time (pair test, N=8, Z= -2.1, p= 0.036) and number of food species consumed annually: Group-G 18 food species (range 5-10) and Group-S 67 food species (range 18-28) (Fig. 3).

The groups also differed in the number of food species contributing more than 1% of total feeding time [15 species contributed 78.9% of feeding time in Group-G, while 23 species contributed 34.3% in Group-S]. Together, 31 species contributed more than 1% of total feeding time, of which 8 species were exclusive to Group-G, 16 to Group-S, and 7 were common to both groups. A significant positive correlation

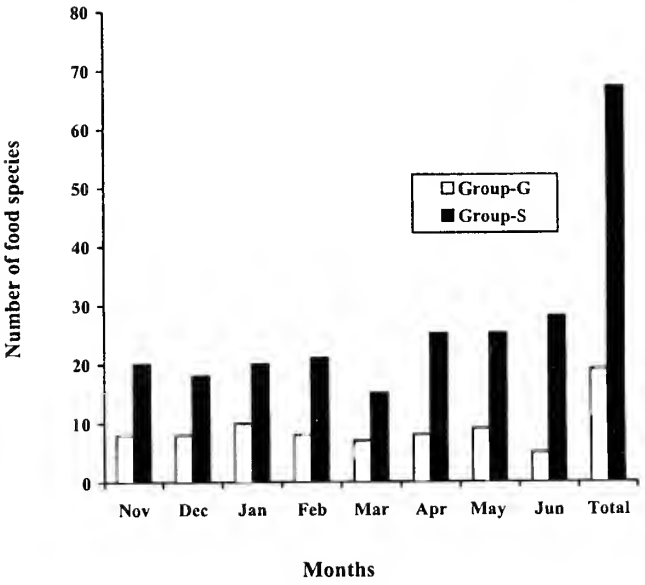

Fig. 3: Number of food plant species used by Group-G and Group-S

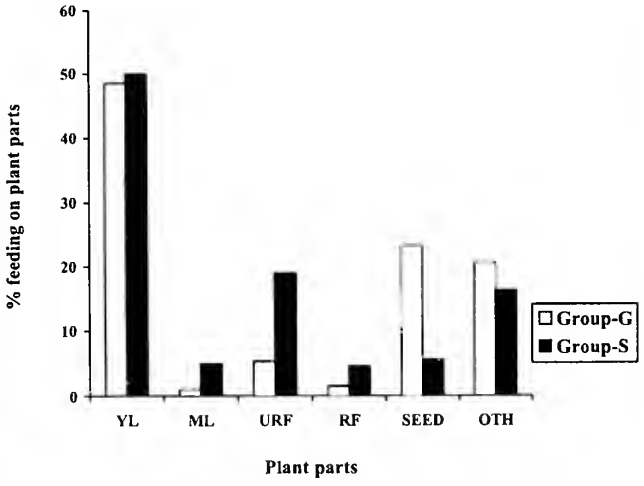

Fig. 4: Percent time spent feeding on different plant parts by Group-G and Group-S

existed between time spent feeding and availability of most food species in their respective home range (r_s = 0.747, $p < 0.001$ for Group-G and r_s = 0.82, $p<0.001$ for Group-S). Thus, both groups differed in their use of the seven common food species according to the abundance of the food species (Table 1).

Top-ten food species

In Group-G and Group-S, the top-ten food species accounted for 87.8% and 59.1% of total feeding time, respectively. Only one species (*Mikania scandens*) was common to both groups (Table 1). In Group-G, preference for top-ten food species was in accordance with their abundance ($r_s = 0.729$, $p < 0.05$), but not so in Group-S ($r_s = 0.309$, $p > 0.1$).

The two groups also differed in the maximum feeding time spent on a single food species: Group-G on *Albizzia procera* (27.8%) and Group-S on *Ficus racemosa* (7.6%).

Both groups spent almost the same time feeding on young foliage (about 48%), but differed in the use of other plant parts. Second to young foliage, Group-G preferred seeds (23.2%) and Group-S unripe fruit (17.6%). Group-S spent almost equal durations on mature leaves (5.8%) and seeds (6%) (Fig. 4).

Furthermore, the two groups differed in their use of feeding substratum. Group-G never descended to the ground for feeding, while Group-S spent about 7.3% of the total feeding time on the ground, feeding on germinating seeds and ripe fruit (Gupta 1996). Both the groups also differed in their animal diet; it was higher for Group-S (0.05%) than for Group-G (0.01%).

The soil is poor and acidic due to repeated *jhum* once in 2 to 3 years. The density of *Ficus* species was low in the repeated *jhum* areas compared to non-*jhum* areas (Gupta 1996). The estimated tree density was 280 trees/ha, but the diversity of food trees used by the Langur was relatively low at 22 species/ha (Gupta and Kumar 1994).

DISCUSSION

Abundance of food plants

Although there was a correlation between abundance and percentage time spent feeding, the selection of any particular food species by both groups was not simply a function of abundance.

One such case is the use of *Albizzia procera*. In Gumti, *A. procera* was less abundant (20 trees/ha) than *C. arborea* and moroi (*Albizzia lebbek*) (44 and 72 trees/ha, respectively), but was consumed more (27.9% mostly for seeds) than *C. arborea* (16.8%) and moroi (*Albizzia lebbek*) (1.5%). In contrast, *A. procera* was more abundant (2.2 trees/ha) in SWLS than at least five other top-ten food species (*Ficus racemosa*, *F. fistulosa*, *Syzygium fruticosum*, *Delonix regia* and *Dillenia pentagyna*), but its consumption was much less (almost negligible for seeds) than any of them. Group-S consumed the seeds of *Acacia auriculiformis* and *Delonix regia*, both less abundant than *A. procera*. This suggests that Group-G preferred *A. procera*, and Group-S preferred *A. auriculiformis* and *D. regia*.

Rudran (1978) studying two groups of Blue Monkeys (*Cercopithecus mitis stuhlmanni*) concluded that dietary differences between groups can be explained by differences in tree species' density in their home ranges, and by local variation in phenological activity of food plants. In this study,

Table 1: Percentage time spent feeding and density of food species for Group-G and Group-S of Phayre's langur

Species	Group-G			Group-S		
	% Feeding	Density/ha	PI	% Feeding	Density/ha	PI
Albizzia procera[*]	27.8	20	1.9	-	-	-
Melocanna bambusoides[*]	18.3	nr	-	-	-	-
Callicarpa arborea[*]	16.3	44	1.0	-	-	-
Litsea sp. (medda)[*]	1.7	12	1.5	-	-	-
Odina wodier	1.3	16	0.1	-	-	-
Albizzia lebbek[*]	5.3	16	1.5	-	-	-
Albizzia sp. (moroi)	1.5	72	0.1	-	-	-
Macaranga denticulata[*]	1.7	16	1.5	-	-	-
Albizzia stipulata[*++]	8.5	16	4.2	1.9	0.5	2.9
Gmelina arborea[*++]	4.1	8	2.6	2.4	0.2	17.9
Mikania scandens[*++]	2.1	nr	-	6.0	nr	-
Dioscorea alata[*++]	2.1	nr	-	3.1	nr	-
Ficus hispida[++]	1.3	nr	-	6.7	9.7	3.0
Ficus indica[++]	0.9	16.0	0.9	4.3	2.4	1.7
Terminalia bellerica[++]	1.5	nr	-	2.0	6.8	0.4
Gardenia turgida	-	-	-	1.3	0.1	35.3
Ficus fistulosa[*]	-	-	-	7.4	0.4	21.9
Ficus racemosa[*]	-	-	-	7.6	0.2	14.7
Syzygium fruticosum[*]	-	-	-	5.8	0.4	13.4
Delonix regia[*]	-	-	-	5.6	0.5	9.8
Streblus asper	-	-	-	1.9	1.3	9.3
Adenanthera pavonina	-	-	-	3.6	0.9	6.0
Artocarpus lakoocha	-	-	-	3.9	2.2	0.7
Stereospermum personatum	-	-	-	1.2	0.4	4.0
Swietenia mahogani	-	-	-	2.5	2.2	2.8
Dillenia pentagyna[*]	-	-	-	4.0	2.2	1.6
Hevea braziliensis	-	-	-	2.2	4.5	1.2
Acacia auriculiformis[*]	-	-	-	6.7	18.7	0.9
Artocarpus chaplasha[*]	-	-	-	4.8	6.6	0.7
Vitex peduncularis	-	-	-	1.1	2.8	0.1
Schima wallichii	-	-	-	1.0	22.6	0.1

nr = not represented
[*] = Top-ten food species
[++] = 7 common food species for both groups
PI = Preference Index

however, differences in soil condition and other geographical variations did not have any effect on the productivity cycle (phenology) of different plant parts (Gupta and Kumar 1994; Gupta 1996) of *A. procera* flowering and fruiting normally at Gumti and Sepahijala.

Habitat disturbance and adaptability

Dietary differences in the two groups can also be attributed to the changes in the habitat following various types of human disturbances. Repeated *jhum* may lead to poor acidic soils (Ramakrishnan 1992) that could have been the case in Gumti WLS favouring leguminous trees (*A. procera*), which would result in more seed eating (23.2%). Recent studies on African colobines (Maisels *et al.* 1994; Gartlan *et al.* 1986; Oates *et al.* 1990) have shown that (a) relative abundance of legumes increases with increasing soil poverty. Increasing abundance of legumes increases the availability of nutrient rich seeds, and hence there is more seed eating; (b) the seeds and young leaves of leguminous trees are frequently nutrient rich and among the preferred food of colobines, though legume species are often associated with nutrient-poor soil (Richards 1977).

No feeding by Group-S on *A. procera* seeds could be associated with their poor nutrient value in Sepahijala. The preference for seeds of *A. auriculiformis* and *D. regia* could be associated with differences in nutrient values vis-à-vis *A. procera*. However, a chemical analysis of *A. procera* seeds for their nutrient values, from both study sites, is a must for

comparison with the nutrient values of other food species (bamboo, *Callicarpa arborea* and *A. stipulata* in Gumti; and *Ficus racemosa*, *F. fistulosa*, *A. auriculiformis*, *F. hispida* in Sepahijala). Johns *et al.* (1978) showed that the levels of certain chemicals in plants differ among geographic localities, with the result that they are eaten more in some areas than in others. In addition, studies on Howler Monkeys (Glander 1981) and Spider Monkeys (Van Roosmalen 1982) have shown that the selection of individual food trees was associated with their intraspecific differences in nutrients and secondary compounds.

In Gumti, low plant diversity due to *jhum* restricted the choice of food plants for Group-G, which used only 19 food species. Of these, 5 species accounted for more than 75% feeding time, including one single species (*A. procera*) contributing 27.8% feeding time. In Sepahijala, *jhum* was absent and human disturbance was restricted to trespassing, collection of minor forest products, and illicit felling. As a measure to counter these disturbances, the natural forest patches were fortified with plantations (including *Acacia auriculiformis*, *Delonix regia*, *Gmelina arborea*, *Artocarpus lakoocha*, *A. chaplasha*, *Caesalpinia pulcherrima*, *Leucaena leucocephala* and *Adenanthera pavonina*) offering more choice of food items to Group-S (67 food species and no single species accounted for more than 8% of total feeding time).

CONCLUSION

Dietary differences between two groups of Phayre's Langur could be explained as a combined result of various factors. All these factors are inter-related and influence the dietary patterns of the langurs. Of the different factors discussed, adaptability of the langurs to the changes in their respective habitats, however, appears to be the most important. Adaptability allowed Group-G and Group-S to survive under different habitat conditions. This adaptability hypothesis does provide information on preferences for specific food plant species by both the groups. Information on preferred food plant species by each group could be vital to wildlife managers, while selecting suitable plant species while undertaking gap or new plantations as wildlife habitat improvement measure.

Detailed knowledge on the feeding ecology of an animal species is one of the most important requirements for designing its conservation strategy. Based on the differences observed in the dietary patterns of two groups of Phayre's Langur in closely located Gumti and Sepahijala Wildlife Sanctuaries, the conservation strategy for this species will have to be specialized for a given habitat type. This may also hold good for other indicator wildlife species in closely located Protected Areas. It would, thus, be imperative for wildlife managers to opt for species- and area-specific ecological studies on key indicator/flagship wildlife species for effective planning and execution of suitable conservation strategies at microhabitat levels.

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REFERENCES

AGRAWAL, V.C. (1974): Taxonomic status of Barbes' leaf monkey, *Presbytis phayrei* Blyth. *Primates 15(2-3)*: 235-239.

ALTMANN, J. (1974): Observation study of behaviour: sampling methods. *Behaviour 49*: 227-267.

CHAPMAN, C.A. & L.M. FEDIGAN (1990): Dietary differences between neighbouring *Cebus capicinus* groups: local traditions, food availability or responses to food profitability? *Folia Primatologica 54*: 177-186.

CHOUDHURY, A. (1986): Discovery of Phayre's leaf monkey in Assam. *The Sentinel* 1-1.

FREELAND, W.J. & D.H. JANZEN (1974): Strategies in herbivory by mammals: the role of plant secondary compounds. *American Naturalist 8(961)*: 269-289.

GARTLAN, J.S., D. MCC. NEWBERY, D.W. THOMAS & P.G. WATERMAN (1986): The influence of topography and soil phosphorus on the vegetation of Korup Forest Reserve, Cameroon. *Vegetatio 65*: 131-148.

GLANDER, K.E. (1981): Feeding pattern in mantled howler monkeys. Pp. 231-259. *In*: Foraging Behaviour: Ecological, Ethological and Psychological Approaches (Eds: Kamil, A. and T.D. Sargent). New York, Garland Press.

GUPTA, A.K. (1994): Status and conservation of non-human primates in Tripura, India. *In*: Current Primatology, Vol. 1: Ecology and Evolution (Eds. B. Thierry, J.R. Anderson, J.J. Roeder and N. Herrenschmidt). Strasbourg, Univ. Louis Pasteur.

GUPTA, A.K. (1996): Conservation Ecology of Primates and Human Impact in Northeast India. Ph.D. Dissertation. University of Cambridge, United Kingdom. 528 pp.

GUPTA, A.K. (1998): A note on a review of the taxonomic status of Phayre's langur (*Trachypithecus phayrei*) in Tripura, North-east India. *Folia Primatologica 69(1)*: 22-27.

GUPTA, A.K. & A. KUMAR (1994): Feeding ecology and conservation of

the Phayre's leaf monkey (*Presbytis phayrei*) in northeast India. *Biological Conservation 69*: 301-306.

GUPTA, A.K. & S.K. MUKHERJEE (1994): A note on the release of golden langur (*Presbytis geei*) into the wild in Tripura, India. *Indian Forester 120(10)*: 915-919.

JOHNS, A.D., R.J. KEYMER & W.M. ELLIS (1978): Cyanogenesis in plants and animal feeding. Pp. 21-34. *In*: Biochemical Aspects of Plants and Animal Co-Evolution (Ed.: Harborne, J.B.). Academic Press, London.

KUMMER, H. (1971). Primate Societies. Aldine Press, Chicago. 160 pp.

MAISELS, F., A. GAUTIER-HION & J.P. GAUTIER (1994): Diets of two sympatric colobines in Zaire: more evidence on seed eating in forests on poor soils. *International Journal of Primatology 15(5)*: 681-701.

MCGREW, W.C. (1983): Animal foods in the diet of wild chimpanzees (*Pan troglodytes*): why cross-cultural variations? *Journal of Ethology 1*: 46-61.

MOWRY, C.B., B.S. DECKER & D.J. SHURE (1996): The role of phytochemistry in dietary choices of Tana River Colobus monkeys (*Procolobus badius rufomitratus*). *International Journal of Primatology 17(1)*: 63-84.

NISHIDA, T., R.W. WRANGHAM, J. GOODALL & S. UEHRA (1983): Local differences in plant-feeding habits of chimpanzees between the Mahale Mountains and Gombe National Park, Tanzania. *Journal of Human Evolution 12*: 467-480.

OATES, J.F., T. SWAIN & J. ZANT (1977): Secondary compounds and food selection by colobus monkeys. *Biochemical Systematics and Ecology 5*: 317-321.

OATES, J.F., G.H. WHITESIDES & A.G. DAVIES (1990): Determinants of variations in tropical forest primate biomass: new evidence from West Africa. *Ecology 71(1)*: 328-343.

RAMAKRISHNAN, P.S. (1992): Shifting agriculture and sustainable development: An interdisciplinary study from North-Eastern India. The Parthenon Publishing Group, U.S.A. 424 pp.

RICHARDS, A. (1977): The feeding behaviour of *Propithecus verreauxi*. Pp. 72-96. *In*: Primate Ecology (Ed.: Clutton-Brock, T.H.). London, Academic Press.

RICHARDS, A.F. (1985): Primates in Nature. W. H. Freeman & Co., New York. 519 pp.

RUDRAN, R. (1978): Intergroup dietary comparisons and folivorous tendencies of two groups of blue monkeys (*Cercopithecus mitis stuhlmanni*). Pp. 483-503. *In*: The Ecology of Arboreal Folivores (Ed.: Montgomery, G.G.). Smithsonian Institution Press, Washington D.C.

SCHLICHTE, HANS-JORG (1978): The ecology of two groups of blue monkeys *Cercopithecus mitis stuhlmanni*, in an isolated habitat of poor vegetation. Pp. 505-517. *In*: The Ecology of Arboreal Folivores (Ed.: Montgomery, G.G.). Smithsonian Institution Press, Washington D.C.

VAN ROOSMALEN, M.G.M. (1982): Habitat preference, diet, feeding behaviour and social organization of the black spider monkey, *Ateles paniscus paniscus*, in Surinam. Ph.D. Dissertation, University of Wageningen, Holland. 175 pp.

WATERMAN, P.G. & G.M. CHOO (1981): The effects of digestibility reducing compounds in leaves on food selection by some colobines. *Malays. Appl. Biol. 10*: 147-162.

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF THE BOMBAY NATURAL HISTORY SOCIETY – 41. FAMILY: EMBERIZIDAE: BUNTINGS[1]

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This part deals with 466 specimens belonging to 21 species and subspecies up to Synopsis Number 2060 of the Indian HANDBOOK (10: 234) and one extralimital specimen. We do not have specimens of one subspecies in our collection.

2041 ***Miliaria calandra*** Linnaeus (Sweden) Corn Bunting 3:218.

17: 7 males, 6 females, 4 unsexed (1 missing*)

1 Mosul, Iraq, 1 Kut, 1 Feluja, Euphrates, Mesopotamia, 1 Zee, Girdal, Pusht-e-Kuh, 1 Dil Khusha, 3 Mishun, 1 Tang Talao, Persian Gulf, 1 Sheik Saad, 1 Kazerun, Persia, 2 Shustar, S. Persia, 1 Katunak 8 m SE of Shiraz, 1 Baba Hazi, 19 m SE of Shiraz, 1* Dachigam, Kashmir, 1 Jhang, Maghiana, Pakistan.

The specimens were collected between February 1917 and February 1926, mainly from localities in the Persian Gulf by Hotson, Cheesman, Pitman, Baily, LaPersonne and Kafit, except the Jhang specimen collected by C.B. Ticehurst in December 1917, the second record for the Indian region.

Measurements on p. 11

2042 ***Emberiza leucocephalus leucocephalus*** S.G. Gmelin (Astrakhan) Pine Bunting 3:202.

27: 14 males, 10 females, 3 unsexed.

1 Kilia, Drosh, 6 Chitral, Drosh, 1 Parachinar NWFP, 1 Wana, Waziristan, 2 Hygam, Kashmir, 2 Lahore, 1 Patiala State, 1 Koti State, 1 Daraspur, 4 Jagadri, 1 Ambala, 2 Chandigarh, *4 Peking, China.*

The Chinese specimens were collected by Maj. H.J. Walton on February 25, 1901 and Chitral specimens by Perreau in March 1903. The rest date back from 1909 to 1922, and a single specimen from Parachinar to February 1944.

Very distinct from other buntings, there can be a slight confusion with the female White-capped (*E. stewarti*), but the larger size and bolder streaks separate it from the smaller White-capped females.

Measurements on p. 11

2043 ***Emberiza melanocephala*** Scopoli (Carniola) Black-headed Bunting 3:213.

80: 49 (2 by plumage) males, 26 females (1 missing*), 5 unsexed.

2 Tamb Island, Mesopotamia, 5 Feluja, R. Euphrates, 3 Shiraz, 2 Amara, 2 Bid-e-zard, 2 Mishun, 1 Bushire, Persian Gulf, 1 Robkan, Tuhat, 2 Bagh-Dil-Khussa, 1 Bagh Rezi, 1 Ieghab, 108 m.s. of Kalat, 1 Kochau, Greshag, 122 m.s.w. of Kalat, 1 Koral, 107 m.s. of Kalat, 1 Teghat, 107 m.s. of Kalat, 1 Kalat*, 1 Sunit-i-Fasil, 6 m. s.w. of Gusht, 2 Harboi, Baluchistan 1 Pulabgimi, 1 Hyderabad, Sind, 1 Karachi, 1 Chobari, Kutch, 2 Dohad, 1 Gir forest, Amreli dist; 1 Changalra, 1 Bhuj, 1 Rapar, 1 Kuar Bet, Bunni, Kutch, 1 Dabka, Baroda, 1 Amjhera, Gwalior, 1 Indore. One line type 1 Pachora, E. Khandesh, 1 Suria Mahal, 3 Nasik, 1 Sanpada, Belapur Road, 4 Belapur, 1 Panvel, 14 Bhiwandi, 1 Wada, Thana Dist., 1 Kalyan, 1 Andheri, 1 Santacruz, 1 Khandala, 2 Poona, 1 Ratnagiri, 1 Molem, Goa, 1 Cage bird, 1 Bombay market.

Measurements on p. 11

2044 ***Emberiza bruniceps*** Brandt (Turkmenia) Red-headed Bunting 3:215.

23: 20 (3 by plumage) males, 3 females.

2 Kain, Persia, 1 Yepchan, Chinese Turkestan, 1 Kashgar, China, 1 Chitral, 2 Chitral Drosh, 3 Cawnpur, 2 Surwaya, Gwalior, 1 Berar, 2 Crawford market, Bombay, 2 Tiretta Bazar*, Calcutta.

A male specimen, no. 7914 collected from Surwaya, Gwalior by Sálim Ali on March 18, 1938 is a freak as far as the bill is concerned, with an upper mandible of 24 mm and a lower mandible of 18.5 mm, which is almost double the normal length. *Two male specimens purchased from Tiretta Bazar, Calcutta (=Kolkata) by C.M. Inglis have very small wings and were not included in the measurements. One of them is a partial albino with white wings.

The females are difficult to separate from the females of Black-headed Bunting as they are similar in size, but they differ in having a smaller bill, and rump with a yellow wash.

Measurements on p. 11

2045 ***Emberiza rutila*** Pallas (Onon R., SE. Transbaicalia) Chestnut Bunting 3:216.

8: 6 males, 1 female, 1 unsexed

3 Peking, China, 2 Nyannggyo, 1 Paukkaung, 2 Prome Dist., Myanmar.

MEASUREMENTS PART 41

	Wing (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
		2041 *Miliaria calandra*		
Males 7	98-105 av. 100.7	11.8-13 av.12.4	24-27 av. 25.6	69-76 av. 72.5
	(IH m/f 89-101	from skull 12-15	24-27	67-76)
Females 6	91-98 av. 94	10.7-12.2 av. 11.5	24-25.3 av. 24.6	64-69 av. 66.5
		2042 *Emberiza leucocephalus leucocephalus*		
Males 14	90-95 av. 91.3	10-11.5 av. 10.5	19.5-21.5 av. 20.3	74-80 av. 76.1
	(IH m/f 88-96	from skull 12-14	*c.* 20	78-82)
Females 10	86-93 av. 88	10-11.1 av. 10.6	19.5-21 av. 20.2	67-78 av. 72.1
		2043 *Emberiza melanocephala*		
Males 49	83-98 av. 95.1	12.5-15 av. 13.4	20-24.2 av. 22	66-80 av. 71.6
	(IH 92-100	from skull 15-17	20-23	68-78)
Females 25	84-90 av. 87.1	11.5-13.7 av. 12.7	20.5-23 av. 21.7	62-72 av. 67.5
	(IH 85-92	from skull 16-17	21-22	65-71)
		2044 *Emberiza bruniceps*		
Males 18	84-90 av. 87.1	11.3-13.3 av. 12.4	19-23 av. 21	64-74 av. 69
	(IH 85-90	from skull 16-17	19-22	69-70)
Females 3	80 (2), 84	11.2, 11.7, 12	20.5 (3)	66 (2), 70
	(IH 82-85	from skull 15-16	19-22	65-67)
		2045 *Emberiza rutila*		
Males 6	72-78 av. 74.6	9.5-10.8 av. 9.9	18.7-20 av. 19.1	52-59 av. 56.8
	(IH m/f 74-77	from skull *c.* 14	19-20	56-59)
Female 1	69	9.8	19.3	53
		2046 *Emberiza aureola aureola*		
Males 18	72-82 av. 76.2	10-12 av. 11	20-21.7 av. 20.6	51-64 av. 57.1
	(IH 77-83	from skull 13-14	20-21	57-68)
Females 3	69, 71, 73	9.8, 10.3, 10.5	18.5, 19.5, 20	50, 53 (2)
	(IH 72-76	from skull 13-14	20-21	54-60)
		2047 *Emberiza spodocephala sordida*		
Males 4	70-75 av. 72	10-11 av. 10.3	19.5-20.5 av. 20	56-64 av. 60.2
	(IH m/f 74-79	from skull 14-15	*c.* 19	60-64)
Female 1	70	10.5	20.5	64
		2048 *Emberiza stewarti*		
Males 18	76-85 av. 80.5	9.3-10.8 av. 10	17.2-19.5 av. 18.5	66-75 av. 70.7
	(IH 78-82	from skull 12-14	18-19	64-70)
Females 12	71-79 av. 75	9.7-10.5 av. 10.1	18-19 av. 18.4	64-73 av. 67.2
	(IH 72-81	from skull 12-14	18-19	64-70)
		2049 *Emberiza hortulana*		
Males 8	81-92 av. 88.2	10.2-11 av. 10.4	19-21 av. 19.6	62-71 av. 67
	(IH 80-92	from skull *c.* 14	19-20	62-68)
Female 1	80	11	19.5	60
	(IH 78-90	from skull *c.* 14	19-20	62-68
		2050 *Emberiza buchanani buchanani*		
Males 11	86-93 av. 88.1	10-11.6 av. 11	18.7-20.5 av. 19.9	70-76 av. 72.5
	(IH 85-93	from skull 13-15	19-22	69-79)
Females 4	79-84 av. 82.3	10.2-11 av. 10.6	19.5-20.4 av. 19.9	65-73 av. 68.3
	(IH 81-88	from skull 12-15	19-20	67-72)

MEASUREMENTS PART 41 (*contd.*)

	Wing (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
		2051-52 *Emberiza cia* subspp.		
Males				
E.c. par 10	82-88 av. 85.4 (IH 80-87	10-11 av. 10.3 from skull 13-14	19-21.2 av. 19.8 19-21	75-81 av. 77.9 75-81)
E.c. stracheyi 31	75-89 av. 82.4 (IH 75-89	10-11 av. 10.5 from skull 13-14	19.5-21 av. 20.9 19-21	67-82 av. 75.1 71-79)
Females				
E.c. par 12	78-83 av. 80.7 (IH m/f 78-87	9.5-10.7 av. 10 from skull 13-14	19.5-20.5 av. 19.9 19-21	72-75 av. 73.8 66-79)
E.c. stracheyi 11	76-88 av. 79.5	10-11.5 av. 10.5	19.5-20.5 av. 19.9	69-78 av. 72.4
		2053a *Emberiza godlewskii khamensis*		
Males 2	88, 92 (Clive Byers - 83-89.5	11, 11.4 from skull - 12.2-14.9	20.8, 21.2 16.6-19.5	81, 88 77.5-91)
Female 1	93 (Clive Byers 79.5-83	11.6 from skull - 12.3-14.3	21 17.3-19.3	88 76.5-81.5)
		2055, 2055a *Emberiza fucata* subspp.		
Males				
E.f. arcuata 7	68-73 av. 70.1 (IH 69-71	10-11 av. 10.4 from skull 15-16	20-21 av. 20.5 22-23	60-70 av. 65.1 65-67)
E.f. fucata 2	68, 71 (IH m/f 71-76	10.2, 11 from skull 15-16	20.5, 21 22-23	61 (2) 62-65)
		2056 *Emberiza pusilla*		
Males 24	68-77 av. 71.4 (IH m/f 66-74	8.5-9.7 av. 9 from skull 10-13	17-19 av. 18.2 17-22	53-66 av. 57.2 54-61)
Females 9	67-73 av. 70	8.5-9.7av. 8.9	18-19 av. 18.5	55-60 av. 56.3
		2057 *Emberiza striolata*		
Males 11	76-81 av. 78.7 (IH 73-85	9-10.1 av. 9.5 from skull 11-13	16-17 av. 16.5 15-16	59-64 av. 61.1 56-65)
Females 3	75 (2), 78 (IHb72-80	9.5 (3) from skull 11-13	16.5, 17 (2) 15-16	56, 59, nil 56-63)
		2058-59 *Emberiza schoeniclus* subspp.		
Males				
E.s. pallidior 9	71-85 av. 79 (IH 80-85	8-9.7 av. 9 fom skull c. 13	19-21 av. 19.9 c. 21	57-68av. 63.5 65-70)
E.s. pyrrhuloides 4	81-88 av.83.2 (IH 77-80	10-11.2 av. 10.4 fom skull 12-14	20-22.5 av. 21.5 20-22	69-77 av. 72.2 72-80)
Females				
E.s. pallidior 10	68-79 av. 74.4 (IH 71-79	8.2-9.5 av. 8.9 from skull c. 13	18.5-20 av. 19.6 c. 21	59-69 av. 63.3 65-70)
E.s. pyrrhuloides 1	80 (IH 75-83	10.5 from skull 12-12	21 20-22	73 72-80)
		EL *Emberiza citrinella*		
Males 2	83, 92 (Clive Buyers - 80-97	10.5 (2) from skull - 10.7-13.9	19, 20 17-21.3	70, 73 62-79)

MEASUREMENTS PART 41 *(contd.)*

	Wing (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
		2060 *Melophus lathami*		
Males 32	76-86 av. 82 (IH 79-86	10.5-12.9 av. 11.6 from skull 13-16	20-22 av. 20.7 19-21	64-73 av. 67 61-69)
Females 15	75-81 av. 77.6 (IH 76-80	10.1-12 av. 11.1 fom skull 13-16	19.5-21.5 av. 19-21	62-68 av. 64 63-69)

A small, colourful finch with a fine bill. The unsexed specimen collected from Paukkaung on January 17, 1929 by J.K. Stanford is a juvenile with streaks on the crown and mantle, and chestnut rump and uppertail coverts.

Measurements on p. 11

2046 ***Emberiza aureola aureola*** Pallas (Irtysh River, Siberia) Yellow-breasted Bunting 3:210.

22: 18 males (2 by plumage), 3 females, 1 unsexed.

1 Jagadri, Ambala, 4 Goalpara, 2 Dibrugarh Assam, 1 Moirang, Manipur, *3 Kyitha, 1 Padaung, 1 Prome, 1 Myogurin, 1 Henzada, Myanmar, 1 Temple of Heaven, 2 Peking, China,* 4 Bombay market.

Two specimens purchased from Bombay (=Mumbai) market (said to have come from Assam) and one from Peking, collected on June 7, 1901 are in full male breeding plumage with black forehead, face and chin. There are four males from Myanmar, collected on March 1929; one a juvenile with heavy streaks on the crown and mantle, and the other three are attaining breeding plumage, the chins are turning black, still retaining the pale tips to the chestnut mantle.

Measurements on p. 11

2047 ***Emberiza spodocephala sordida*** Blyth (Nepal) Black-faced Bunting 3:212.

5: 4 males, 1 female

1 North Lakhimpur, Assam, *4 Peking, China.*

Three males and one female specimens collected from Peking on May 1901 by Major H.J. Walton are not in good condition. The Lakhimpur specimen collected by Stuart Baker on March 11, 1902 is in fairly good condition, marked as female on the original label, seems to be a male by plumage.

Measurements on p. 11

2048 ***Emberiza stewarti*** (Blyth) (Landour and Dehra Dun) White-capped Bunting 3:203.

30: 18 males, 12 females.

6 Chitral, 1 Kashmir, 2 Rawalpindi, 1 Razani, Waziristan, 1 Quetta, 1 Chagai Hills, Baluchistan, 1 Koti, 2 Kalka, Bhagat, 2 Simla, NWH, 1 Ambala, 1 Ashni River, Patiala, 1 Indsi, 1 Pipli, Karnal, 2 Ganges Canal, Meerut, 2 Bharatpur, 2 Sunda Hills, Jaswantpur, 2 Narwar Fort, Gwalior, 1 Hingolgadh, Jasdan.

These specimens were collected during 1886 to 1939. Easily separated from other buntings, by the grey head and upper breast, black eyestripe and throat in the male. Female has streaked head and mantle, and chestnut rump.

The unsexed Quetta specimen (December 1888) is very pale sandy brown with dark chestnut streaks on the head and mantle.

Measurements on p. 11

2049 ***Emberiza hortulana*** Linnaeus (Europa = Sweden) Ortolan Bunting 3:209.

9: 8 males, 1 female.

1 River Tanhat, Yemen, 1 Feluja, River Euphrates, Mesopotamia, 1 Shaiba, 1 Basra, Iraq, 1 Akbarabad 52° 47' E, 29° 13 N, 1 Bushire, 1 Kazerun, 1 Kain, 1 Qabr-un-Nokada Is. Khor Musa, Persia.

The specimens were collected between March 1897 (male, Busra, W.D. Cumming) and April 1923 (male, Khor Musa, LaPersonne). Very similar to Grey-necked Bunting, but can be separated by the greyish breast band, pale yellow throat and sub-moustachial stripe and boldly streaked brown mantle. Tertials have sharply defined dark brown centres.

Measurements on p. 11

2050 ***Emberiza buchanani buchanani*** Blyth (Indian Peninsula) Grey-necked Bunting 3:208.

18: 11 males, 4 females, 3 unsexed.

1 Tehran, 1 Korak, Kalat, 1 Wahi, Khodgar, 25 m. sw of Khojdar, Baluchistan, 1 Karachi, 1 Mata-no-Madh, 1 Bhujia Fort, Kutch, 1 Deesa, Palanpur, 1 Patan, Mehsana, 1 Dhari, Amreli, Kathiawar, 2 Dohad, Panchmahals, 1 Bodeli, Baroda, 1 Thana, 1 Karjat, 1 Poona Sholapur Road, 30 miles from Poona, 1 Satara, 1 Aurangabad, 1 No locality.

The specimens date back from 1888 (Maj. H.J. Walton, Satara) to 1968. All except one (unsexed specimen collected from Tehran by Cheesman on June 16, 1919) are in winter, non-breeding plumage.

Measurements on p. 11

2051 ***Emberiza cia par*** Hartert (Gudan, Transcaspia) Transcaspian Rock Bunting.

22: 10 males, 12 females

2 Tashkent, Usbek, 1 Kashgar, China, 1 Elbreznits, Tehran, Iran, 1 Attock, 1 Pushkum, Ladakh, 1 Choi, nr Campbellpur, 1 Taxila, 2 Rawalpindi, 1 Jammu, 1 Lahore, 3 Chandigarh, 1 Bahawalpur town env., 1 Harunabad, 1 Chachran, 1 Lalsohara, 2 Manthar, Cholistan, Bahawalpur.

The very distinct head pattern of grey crown with black coronal stripes, on either side, separates the Rock Bunting from the other buntings. *E.c. par* is paler and less rufous above, buffish belly with a light chestnut wash. Median and greater coverts dark brown with light fulvous margins.

Measurements on p. 12

2052 ***Emberiza cia stracheyi*** Moore (Kumaon) Himalayan Rock Bunting 3:205.

51: 31 males, 11 females, 9 unsexed

2 Chitral Kesun, 3 Chitral, 2 Chitral Drosh, 1 Bamhal village, Kashmir, 2 Naolal village, 3 miles below Yus, 1 Near Yus, 3 Liddar valley, 1 Bangar Nulla, Kishtwar, Kashmir, 1 Marwatur Range, Waziristan, 1 Dalhousie, Punjab, 2 Gasa, Kulu, Himachal Pradesh, 1 Narkanda, 14 Simla 1 Kotgarh, Simla Hills, 1 Mashobra, 2 Koti 1 Fagu, 1 Keonthal, 1 Lambathach, 7 Garhwal, 1 Patiala, 1 Kevalea, 1 Gyadzong, S. Tibet.

A much darker race than *par*. Mantle is chestnut-brown streaked with black and the belly is a deeper rufous-chestnut. Median and greater coverts dark brown with light rufous brown margins.

Measurements on p. 12

2053 ***Emberiza cia khamensis*** Sushkin (River Dza-chu, Upper Mekong) Tibetan Rock Bunting 3:207.

See notes on 2053a

2053a ***Emberiza godlewskii khamensis*** Taczanowski (E. Siberia) 1874 Godlewski's Bunting 3:207.

3: 2 males and 1 female

The specimens were collected by A.F.R. Wollaston from Kharta, 12500', S. Tibet in August 1921, during the first Mt. Everest Expedition, and are mentioned by Sir N.B. Kinnear in *Ibis*, 1922: 495-526. They are marked *E. cia godlewskii* (Godlewski's Meadow Bunting) in the original label, as in Stuart Baker's FAUNA OF BRITISH INDIA 3: 207. The distribution is given as Northern China and southeast Tibet, wintering in Sikkim and hills of Northern Assam.

"The birds are in a very worn and faded state of plumage which renders identification a matter of some difficulty" according to the collector. But I could observe a few characters in the specimens, which warrants their placement in Godlewski's Bunting rather than in Rock Bunting. In *Emberiza cia* (Rock Bunting), sexes can be separated by plumage, but in *godlewskii* there is little difference between the sexes. Even in the much worn plumage, the upper wing bar is pure white instead of the buffish wing bar of Rock Bunting. The very prominent head pattern of the Rock Bunting is absent here. There are a few grey feathers on the centre of the crown with dark chestnut feathers laterally, not forming any striped pattern. Other characters mentioned in BUNTINGS AND SPARROWS by Clive Byers, Urban Olsson and Jon Curson, 1996, are not apparent in our specimens. I am placing them in *khamensis* based on distribution, since I did not have other races to compare with.

Measurements on p. 12

2054 ***Emberiza cia yunnanensis*** Sharp (Gyi-dzin-shan, east of Talifu) Yunnan Rock Bunting 3:207.

Nil.

2055 ***Emberiza fucata arcuata*** Sharpe (Himalayas, restricted to Simla by Baker) Indian Grey-headed Bunting 3:199.

8: 7 males, 1 unsexed

1 Dachigam, 1 Bhadrawar, Kashmir, 1 Fagu, Keonthal, 3 Yoshimadh, Garhwal, 1 Ambala, Punjab, 1 The Fimba?

The key in Indian Handbook correctly separates *arcuata* from the nominate subspecies by its pure grey head and rich chestnut upper parts. In addition to these, the ear coverts are deeper chestnut and streaks on the head are broader than those of the nominate subspecies.

Measurements on p. 12

2055a ***Emberiza fucata fucata*** Pallas (Onon and Ingoda Rivers) Amur Grey-headed Bunting.

3: 2 males, 1 unsexed.

1 Peking, China, 1 N. Lakhimpur, Assam, 1 Moirang, Manipur.

The head is brownish with a touch of grey and finer streaks. Upper parts and ear coverts light chestnut compared to *arcuata*.

Measurements on p. 12

2056 ***Emberiza pusilla*** Pallas (Transbaikalian Alps) Little Bunting 3:200.

44: 24 males, 9 females, 11 unsexed.

Hawiplain, Mesopotamia, 4 Temple of Heaven, 10 Peking, China; 2 Temi, W. Sikkim, 2 Sikkim, 1 Batase, 1 Shamgong, C. Bhutan, 2 Rongtong, 3 Wamrong, 5 Gomchu, 1 Deothang, E. Bhutan, 1 Bhutan *duars*, 6 Goalpara, 1 Shillong, Assam, 1 Taungup Pass, Prome, 1 Prome, *1 South Shan States, Myanmar, 1 Bareily Market.*

The fourteen Chinese specimens were collected by Maj. H.J. Walton in October 1900 to May 1907, and Bhutan specimens in February/March 1966 and March-April 1967 by Sálim Ali.

A small bunting with a deep rufous, central coronal stripe and two broad black stripes on the sides of the crown, not likely to be confused with any other bunting, except perhaps with the female Reed Bunting, but can be separated by the rufous streaking on breast and flanks, whiter lower

breast and belly; forked tail with pointed rectrices, the outermost pair being almost white.

Measurements on p. 12

2057 ***Emberiza striolata*** (Lichtenstein) (Ambukol, Nubia) Striolated Bunting 3:217.

18: 11 males (3 by plumage), 3 females, 4 unsexed.

3 Charbar, Persian Gulf, 2 Burida Pass, Kalat, 1 Jaun Khozdar, 1 Chaman, Baluchistan, 1 Sind, 1 Mubarakpur near Ambala, 1 Chandigarh, 2 Lal Sohara, Bahawalpur, 1 Bhujia Fort, 1 Bhuj, 1 Kutch, 1 Deesa, Palanpur, 1 Hingolgadh, Jasdan, 1 Indore.

A bunting with characteristic black streaks on a greyish-white head. Female has sandy brown crown with dark brown streaks. Shorter tail with almost roundish tips to the rectrices, lacks white in the tail. The outer margin and tips of outer pair of rectrices dark rufous. Sexes easily distinguishable.

Measurements on p. 12

2058 ***Emberiza schoeniclus pallidior*** Hartert (Aiderli, Turkestan) Central Asian Reed Bunting 3: 197.

22: 9 males, 10 females, 3 unsexed.

1 Oxfordshire, 1 Kashgar, 1 Hunting Park, 7 Peking, 1 Khotan, Sinkiang, China; 1 Sheik Saud, 1 Amara, 1 Mesopotamia, 1 Chaman, Baluchistan, 1 Attock, River Indus, 1 Campbellpur, 3 Rawalpindi, 2 Jagadri, Ambala, Punjab.

All specimens were collected during winter, November/ December 1900 to March 1931. The black head, cheeks, chin and throat of the males have a mottled appearance, due to the brown fringes of feathers. Females have a streaked head.

Measurements on p. 12

2059 ***Emberiza schoeniclus pyrrhuloides*** Pallas (Astrakhan) Thick-billed Reed Bunting. Nil

6: 4 males (1 by plumage), 1 female, 1 unsexed.

2 Engeli, Persia, 1 Yarkand, 2 Keriya, 1 Khotan, Sinkiang, China.

Paler, larger version of *E.s. pallidior,* with a highly arched stouter bill. Female and the unsexed in female plumage have light brown and blackish-brown streaked head. One of the Engeli males - 7940 (28.vi.1919, R.E. Cheesman) is in female plumage with streaked head, but with the characteristic conspicuous, broad, buff supercilium of the male. The second Engeli male - 7939 (28.vi.1919, R.E. Cheesman), Keriya male (25.ii.1931, A. Sheriff) and the Yarkand specimen, male by plumage (6.iv.1931, A. Shirriff), all have pure black crown, face, chin and throat, without any light fringes to the feathers. The Engeli specimen (7939) has a brownish-black mantle and dark grey rump, instead of the fulvous and brown streaked mantle and sandy brown rump of the other two males.

Only once recorded from Indian limits at Wular Lake, Kashmir on March 20 by Meinertzhagen (*Ibis* 1927: 394), the inclusion of this race in Indian limits is doubtful.

Measurements on p. 12

EL ***Emberiza citrinella*** Linnaeus (Sweden) Yellow Hammer

2 males

1 Hemel, Hampstead, Herts, U.K., 1 Russia

Measurements on p. 12

2060 ***Melophus lathami*** (Gray) (Canton, Kwangtung) Crested Bunting. 3:221.

49: 32 males, 15 females, 2 unsexed.

1 Bhagat, 1 Jabli, 1 Koti, NWH, 1 Gupta Kashi, 1 Mussooree, 1 Ranikhet, 1 Kedarmal, Almora, 1 Sonaripur, Kheri Dt., 1 Patiala, 1 Ambala, 1 Sunda Hill, 1 Jaswantpur Dt., 1 Narwar Fort, Gwalior, 1 Indore, 1 Dohad, 2 Dediapada, Rajpipla, 1 Kolkaz, Melghat, Berar, 1 Bees Aam, Amravati, Melghat, 2 Wagheri, 1 Trimbok road, Nasik, 1 Raita, 1 Wada, 1 Ambatti, Wada road, Thana, 3 Bhiwandi, 1 Khandala, 2 Poona, 1 Mahabaleshwar, 1 Sanchi, Bhopal, 1 Shahaga, 1 Bina, Saugar Dt., 1 Kawnpur, U.P., 6 Baghownie, Darbhanga, 2 Shamgong, Central Bhutan, 1 Rongtong, East Bhutan, 1 Phulguri, N. Kamrup, Assam, *1 Prome Dt., 1 Kamaing, 1 Mong, U. Burma, 1 Jaunggyi, Southshan States, Myanmar.*

The specimens were collected from March 1886 to February 1976. 5 males in female plumage are smaller than the rest of the males and excluded while calculating the average of measurements. 6 males in April, one each in May and August, the rest are all collected during the winter. Among females, one each in April and June, and the rest in winter. Males collected in end January and February from Nasik, Bhiwandi, Shahgarh and Sonaripur have pure black feathers on the crest, mantle and abdomen, whereas 4 females collected in end-March to April from Rongtong, Shamgong (2) and Prome have light brown fringes to the black feathers of mantle and crest.

Measurements on p. 13

(Concluded)

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DORSAL SPOT PATTERN AS UNIQUE MARKERS TO ESTIMATE THE POPULATION SIZE OF *RANA CURTIPES*[1]

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Marking animals with unique marks is necessary for estimating population densities when using the Capture-Recapture Method. The dorsal spot pattern method to identify individuals is considered best for such studies, as it does not cause any physical injury to the animal. Dorsal spot pattern in the bicoloured frog, *Rana curtipes* is shown to be an appropriate method to identify individuals. While studying the population size and density of *Rana curtipes* in the Western Ghats we identified 160 frogs in the Western Ghats of Karnataka by the spot patterns on their dorsum. An identification catalogue, based on the total spot count, spotting patterns and size was prepared for each individual.

Key words: *Rana curtipes*, marking, capture-recapture, photo identification, Western Ghats

Many ecological studies of animals, including population studies, space-use patterns or growth rates, depend on individual-specific marks. Several external marking techniques, like paint, PIT tags and tattoos for reptiles, jaw tagging and dye markers for fishes, leg ring for birds and toe clipping for small mammals (Donnelly *et al.* 1994), have been employed to identify individuals. All these marking techniques involve capture and handling of the animals. Some of the markings are permanent or long lasting, while some are short-lived. Unique natural markings have also been used for studies by a few ecologists. In large mammals like the Tiger, the unique stripe patterns, photographed using camera traps, were used as markers (Karanth 1995). Carlstrom and Edelstram (1946) used photographs of colour patterns on the ventral scales of grass snakes, the throat of slow worms and the dorsum of some lizards, to identify them following recapture. Henley (1981) saved portions of shed skins of study snakes that included unique features, and attached these to the specimen's data card for identifying it later. Shine *et al.* (1988) noted the number and relative position of divided subcaudal scales to identify individual snakes. McDonald *et al.* (1996) used the unique appearance of the pineal spot, or "pink spot", on the top of the head of Leatherback Sea Turtles to recognise individuals. Singh and Bustard (1976) recorded the pattern of pigmented bands and blotches on the tails of hatchling gharials to identify a large number of juveniles in captivity.

Some different types of tags used to mark amphibians are fluorescent pigments, toe clipping, tattooing and PIT tags. Loafman (1991) reports a method of identifying spotted salamander individuals by spot patterns. He describes each animal's pattern as the spots found on head, neck, and body and limbs. The natural variation in belly pattern of the newt *Urodella triturus* has been used to make a catalogue of photographs from which identification of an individual is possible (Sutherland 2000).

While estimating the population size of the free ranging ranid frog *R. curtipes* in the tropical rainforests of the Western Ghats, we identified 160 individuals, by the spots on its dorsum. *Rana curtipes* is an inhabitant of leaf litter and is endemic to the Western Ghats of peninsular Indian states of Karnataka, Kerala, Tamil Nadu and southern Madhya Pradesh (Inger and Dutta 1986; Daniels 1997). Literature on the distribution (Dutta 1992), reproduction (Krishnamurthy and Shakunthala 1997) and hormonal studies of the larva (Varamparampil and Oommen 1997) of this frog are available. However, none of these studies have either used natural pattern mapping to identify individuals or recorded the population status of the species.

METHODS

We studied the population biology of this species in the Bisale Reserve Forest adjoining the Coorg hills, 12° 15' N and 76° 33' E, Karnataka State, India. The study sites were located on the western slopes of the Western Ghats, ranging from 350-860 m above msl. The area is a tropical rainforest (annual average rainfall 5,500 mm) with dense canopy cover and many perennial hill streams. The study was conducted from January 1999 to July 2001.

Rana curtipes are forest frogs, feeding on low flying and crawling insects. They are bicoloured, with olive-golden yellow back, and uniformly black sides, limbs and belly (Daniels 1997). The dorsal side of the frog exhibits colour polymorphism; a majority of them were reddish-yellow and a few had an ashy grey back. Irrespective of the background,

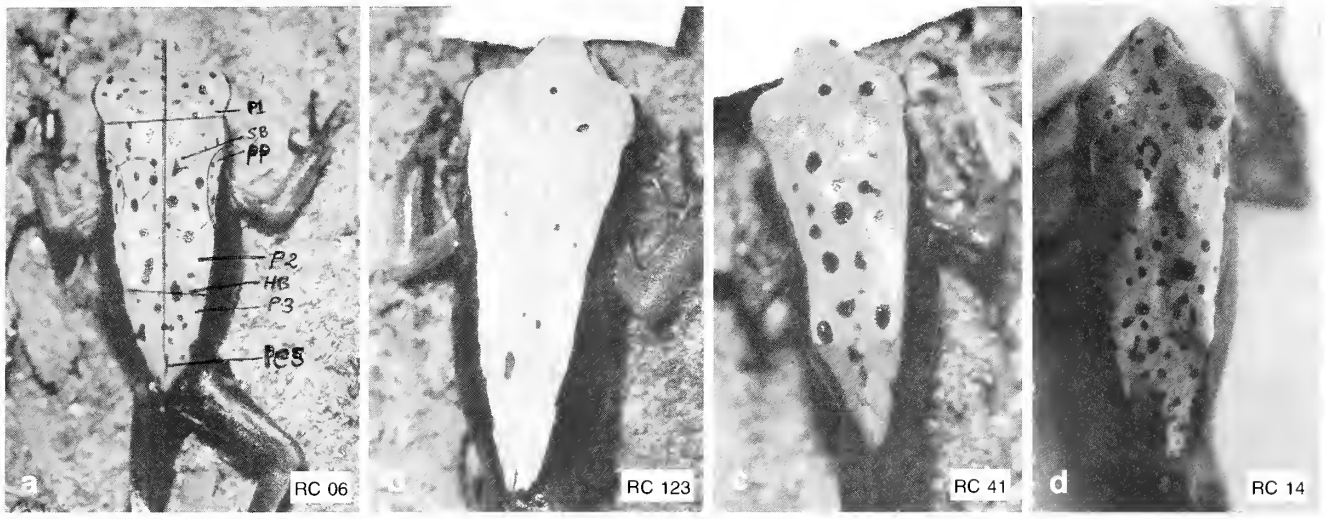

Fig. 1: Some examples from the photo catalogue depicting the unique dorsal spot patterns of *Rana curtipes* and their unique ID numbers
a. Rc 06, b. Rc 123, c. Rc 41, d. Rc 14
P1, part 1; P2, part 2; P3, part 3; PP, parotid patch; SB, Shoulder bone; HB, hipbone; PCS posterior central spot

the dorsal side had numerous black spots with considerable variation in spot frequencies, size, location and designs. A reddish parotid patch may be visible. In breeding pairs the spots were less pronounced, but we did not observe any correlation of spot number or size to the overall size of the frog. The newly emerged frog ranged from 15-18 mm snout to vent length (SVL) (mean SVL 16.5 mm; N=94) and the breeding adults grew to 68.5 mm SVL (N=38).

In general, the dorsal side is marked with black, irregularly shaped spots on an ashy grey or reddish-yellow background (Fig. 1). The total number of spots and the pattern in which they are spread is different in each individual. Based on the total spot count, size and unique spotting patterns, we prepared an identification catalogue for each individual. To make a unique ID for each individual, we divided the dorsum into three parts: P1, P2, P3 (Fig. 1).

Individuals were classified as having high (50 and above), moderate (>20 but <50), low (>10 but <20) or very low (<10) spot count depending on the total count of spots from snout to vent. Once classified, the number of spots in each region, namely P1, P2 and P3 were counted. Some individuals with unique patterns on the back were also noted. The presence or absence of the posterior central spot (PCS) and parotid patch (PP) was noted. The information was tabulated as "spot pattern ID catalogue" (Table 1). On the capture of a frog, its SVL and other dorsal spot pattern data were recorded as per Table 1. An individual identification number was recorded in the first column.

The dorsum of each individual captured was photographed using a Nikon F90X camera with flash and AF Nikkor 105 mm 1:2.8 D lens to get a shadow-free colour picture. A photo identification catalogue of all the 160 frogs sampled in the field was made. All the sampled frogs were released immediately at the site of capture.

These patterns were found to be unique and helped to identify individual frogs. The photo catalogue and spot pattern catalogue was used to identify captured frogs. As the dorsal spot pattern method is reliable and painless compared to other methods, we used it to mark *R. curtipes* to estimate their population size, using capture-recapture method. It was noted that no two frogs captured were identical in the spot pattern nor did the pattern change during the course of this study.

As *Rana curtipes* is a forest floor species, the Quadrat Sampling Method was thought to be more appropriate for quantitative analysis. Frogs were sampled within 8 x 8 m random quadrates within the study area and sampled on 5 occasions. Capture-recapture history was recorded.

RESULTS AND DISCUSSION

Using Petersen Estimate (Bailey's modification), the population size of *R. curtipes* during 1999-2000 was estimated to be 272.33 individuals (standard error 10.97) with a density of 0.08 to 0.1 (N=22 quadrates) frogs per square metre.

The use of natural markings as a means of identification is advantageous as there is no physical injury to the animal. It saves the animal from the stress of capture, marking and handling. While we used this method of photo catalogue, we observed that neither did the normal behaviour of the animal change, nor did the survival rate alter.

Table 1: Dorsal spot pattern catalogue for *Rana curtipes* sampled in the Western Ghats of Karnataka

ID No.	SVL	PP	Total	P1	P2	P3	Notable spot pattern on the back	Posterior central spot (PCS)
Rc06	50.20	+	High	16	30	9	A circle of five spots with a central spot on the right eyelid. On the left shoulder and right shoulder of P2, two circles of six spots with a central dot. An elongated spot touching the left hipbone	Elongated like a comma, but not touching the vent
Rc41	37.42	-	Low	2	14	2	A round spot on the intraorbital region and on the right eyelid. Circle of seven spots with a central spot in the middle of P2, one spot among the seven is key shaped. At the end of P2, three spots (one on each hipbone) forming a triangle if joined	Absent
Rc09	50.30	+	Moderate	4	24	13	A spot on the centre of left eyelid and one at intraorbital region. Two prominent spots on the anterior end of the shoulder bone with a central dot between the two bones. On the right side of P2 "(" marking	Central elongated spot touches the vent and also looks more longer due to the joining of two more spots. "Y" at the vent
Rc14	52.55	-	High	23	39	18	A 3 mm oval spot on the snout, a circle of 4 spots on the right eyelid. A circle due to the joining of 7 spots just before the left shoulder, on the mid right side of the frog a big squarish spot (5 mm), "()" mark on the right hipbone	Elongated touching the vent
Rc123	55.41	-	Very low	2	5	2	A tadpole shaped mark on the anterior of left hipbone	Faint, touching the vent

Note: Only five individuals have been listed as examples in the table

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REFERENCES

CARLSTROM, D. & C. EDELSTRAM (1946): Methods of marking reptiles for identification after recapture. *Nature 168*: 748-749.

DANIELS, R.J.R. (1997): Field guide to the frogs and toads of the Western Ghats. *Cobra 28*: 1-20.

DONNELLY, M.A., C. GUYER, J.E. JUTERBOCK & R.A. ALFORD (1994): Techniques for marking Amphibians. Pp. 277-284. *In*: Measuring and Monitoring Biological Diversity, Standard Methods for Amphibians (Eds: Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek & M.S. Foster). Smithsonian Institution Press, Washington D.C., 364 pp.

DUTTA, S.K. (1992): Amphibians of India: updated species list with distribution record. *Hamadryad 17*: 1-13.

HENLEY, G.B. (1981): A new technique for recognition of snakes. *Herpetol. Rev. 12*: 66.

INGER, R.F. & S.K. DUTTA (1986): An overview of the amphibian fauna of India. *J. Bombay Nat. Hist. Soc. 83 (Suppl.)*: 135-146.

KARANTH, K.U. (1995): Estimating tiger populations from camera-trap data using capture recapture models. *Biological Conservation 71*: 333-338.

KRISHNAMURTHY, S.V. & K. SHAKUNTHALA (1997): *Rana curtipes* (Bicolor frog). Reproduction. *Herpetol. Rev. 28*: 200-201.

LOAFMAN, P. (1991): Identifying individual spotted salamanders by spot pattern. *Herpetol. Rev. 22*: 91-92.

MCDONALD, D.L, P.H. DUTTON, R. BRANDNER & S. BASFORD (1996): Use of pineal spot ("pink spot") photographs to identify leatherback turtles. *Herpetol. Rev. 27(1)*: 11-12.

SHINE, COOPER, N. SHINE, R. SHINE & D. SLIP (1988): Use of subcaudal scale anomalies as an aid in recognizing individual snakes. *Herpetol. Rev. 19(4)*: 79-80.

SINGH, L.A.K. & H.R. BUSTARD (1976): A method to identify individual young gharial (*Gavialis gangeticus*). *Brit. J. Herp. 5*: 669-671.

SUTHERLAND, W.J. (2000): Ecological research techniques. Pp. 65-110. *In*: The Conservation Handbook Research, Management and Policy (Ed. Sutherland, W.J.). Blackwell Science Ltd., Oxford, 278 pp.

VARAMPARAMPIL, T.T. & O.V. OOMMEN (1997): Tricodo thyronin (T3) and thyroxine (T4) levels in *Rana curtipes* during development and metamorphosis. *Indian J. Exp. Biology 35*: 1375-1377.

CHECKLIST OF THE SNAKES OF ARUNACHAL PRADESH, NORTHEAST INDIA[1]

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The present paper is an attempt to prepare a checklist of the snake fauna of Arunachal Pradesh. It is largely based on the first author's zoological exploration and endangered wildlife mapping in the state, as well as on material examined in various museums in the state with the second author. It also includes information from published literature. The list includes 67 species belonging to five families and 31 genera. The distribution and status of each species with remarks are also cited. Brief morphological description of two unidentified species - *Trimeresurus* sp. (*T. stejnegeri* or *T. popeiorum*?, Jar No. SFRI-23) and a Keelback species (Jar No. SFRI-81) are given.

Key words: checklist, snakes, Arunachal Pradesh, northeast India

INTRODUCTION

Arunachal Pradesh, the erstwhile North East Frontier Agency (NEFA), which has been identified as one of the ecological hotspots in the world, is situated between 26° 30' N to 29° 30' N and 91° 30' E to 97° 30' E. The state has a geographical area of 83,743 km^2. From an elevation of 100 m, the area encompasses a series of wet and forest covered rugged mountains and hills, rising up to *c.* 6,000 m. The annual rainfall varies from 500 mm to 6,000 mm, spread over 8-9 months. Owing to the varying agro-climatic and altitudinal conditions, the land supports a phenomenal range of biological diversity. These factors give rise to different climatic regimes and soil structure, which in turn determine the vegetation and faunal communities. The snake fauna best represents this diversity.

There are no records on the snake fauna of the state before the British visited northeast India. The impetus for exploration came with the establishment of British power in the Brahmaputra valley. Cantor (1839) first worked on reptiles in Burma (= Myanmar) and adjoining areas (including Bengal and Assam); he identified *Elaphe porphyracea*, but referred to it as *Coluber porphyraceus* – with a type locality of Mishmi Hills and Abor country (Abor Hills) of present Arunachal Pradesh. This work was followed by many authors, including Wall (1909-1910, 1910) in Upper Assam including Abor, Mishmi and Duffla (Dafla) hills and Namsang near the present Tirap district of the State and Annandale (1911) in Mishmi Hills and (1912a, 1912b) in Abor Hills. After a long gap, another spate of work followed: Smith (1943) which continues to be the authoritative source for identification of Indian snakes, despite being over half a century old, Romer (1949); Waltner (1975a, 1975b, 1975c, 1975d); Mathew (1983, 1995); Sanyal and Gayen (1985); Ghosh (1987); Captain (1997, 1999); Captain and Bhatt (1997, 2000, 2001); Bhatt *et al.* (1988); David *et al.* (2001) and Pawar and Birand (2001).

Considering the great diversity of snakes in Arunachal Pradesh, preparation of a comprehensive checklist was thought to be important. The present work is the result of the first author's 10 years zoological exploration and endangered wildlife mapping in the state, as well as from material examined in various museums in the state with the second author, and partly on published literature. The cut off date for literature search and museum works was end of 2001. The interim checklist (Captain and Bhatt 2000) of 57 species is largely based on specimens from various museums in the State, out of which 31 species are from the State Forest Research Institute (SFRI) Museum, collected by the first author and his associates; 5 species from Zoological Survey of India, Itanagar, 8 species from Miao Forest Museum collected from Namdapha National Park; 1 species from Itanagar Zoo and 12 species based on Ashok Captain's (1997, 1999) observation. At present the SFRI Museum harbours 39 species and 2 unidentified specimens.

Systematic List

The checklist is given as Table 1. The distribution and status of each species with remarks are also cited. In the remarks column, the reference and other details of the museum specimens are given. The systematics and nomenclature, including sequence of orders and families largely follow Smith (1943). Das (1994, 1996, 1997) and Gupta and Rathanasabathy (1997) were also consulted. The list covers 67 species belonging to 5 families and 31 genera, and two unidentified species.

Table 1: Systematic list of snakes in Arunachal Pradesh

Sl. No.	Scientific Name	Distribution & Status	Remarks
	Order: Squamata **Sub-order**: Ophidia (Serpentes) **Family**: Typhlopidae (Worm Snakes or Blind Snakes)		
1.	*Ramphotyphlops braminus* Daudin 1803	Throughout the state in foothills and hills up to 1500 m. Very common.	2 ex. in Miao Forest Museum
2.	*Typhlops jerdoni* Boulenger 1890	Throughout the state. Not common	Annandale (1912a); Smith (1943), p. 50
	Note: *Typhlops diversiceps* Annandale (1912a), Pasighat (originally recorded as Pashighat, Abor country). *In*: *Rec. Ind. Mus* viii. p. 44. pl. v, fig. 1. Smith (1943), p. 50, synonymised under *Typhlops jerdoni* Boulenger 1890.		
3.	*Typhlops diardii* Schlegel 1839	Throughout the state. Plains to hills. Very common.	7 ex. in SFRI Museum: 2 ex. Chessa, K. Kaman; 2 ex. Itanagar, A. Borang; 1 ex. Tippi, A.N. Rao; 1 ex. Itanagar, I. Malla; 1 ex. Itangar, L. Tamang
	Family: Boidae (Pythons and Boas)		
4.	*Python molurus bivittatus* Kuhl 1820	Throughout the state. Common.	2 ex. in SFRI Museum: 1 ex. Itanagar, A. Borang; 1 ex. Itanagar, K. Kaman
	Family: Colubridae (Colubrid Snakes) **Subfamily**: Dipsadinae		
5.	*Pareas monticola* Cantor 1839	Throughout the state. Common in montane forests.	1 ex. in ZSI, Itanagar: Mukto, P.T. Bhutia (2500 m)
	Note: Annandale (1912a), Abor Hills and he found common in foothills. *In*: *Rec. Ind. Mus.* vii, p. 50		
	Subfamily: Colubrinae		
6.	*Elaphe prasina* Blyth 1854	Throughout the state. Plains up to 2500 m. Common.	1 ex. in Miao Forest Museum
	Note: Annandale (1911), Mishmi Hills (Lohit and Dibang Valley districts). *In*: *Rec. Ind. Mus.* vi, p. 218.		
7.	*Elaphe frenata* Gray 1853	Throughout the state. Common.	Captain & Bhatt (2000)
8.	*Elaphe radiata* Schlegel 1837	Throughout the state. Very Common.	3 ex. in SFRI Museum: 1 ex. Itanagar, K. Kaman; 2 ex. Itanagar, A. Borang
9.	*Elaphe taeniura* Cope 1861	Throughout the state. Common in hills.	1 ex. in SFRI Museum: Yachuli, B.B. Bhatt
10.	*Elaphe cantoris* Boulener 1894	Throughout the state. Common in hill forests.	
	Note: K. Haridasan has seen a dead specimen at Putin about 3-4 km away south of NEPCO's Ranganadi Dam site. Photograph was taken and is with the second author. Also Ashok Captain *pers. comm.* 2002.		

Table 1: Systematic list of snakes in Arunachal Pradesh (*contd.*)

Sl. No.	Scientific Name	Distribution & Status	Remarks
11.	*Elaphe porphyracea* Cantor 1839	Throughout the state. Very common in wet forests. Foothills to hills.	2 ex. in SFRI Museum: 1 ex. Namdapha NP (Deban), A. Borang; 1 ex. Chessa, K. Kaman
	Note: The holotype was reported from Mishmi Hills and Abor country (Abor Hills). *In*: Cantor (1839), *Proc. Zool. Soc. London*. p. 51		
12.	*Elaphe mandarina* Cantor 1842	Throughout the state. Common in wet hill forests.	1 ex. in Miao Forest Museum
	Note: *Ablabes pavo* Annandale (1912a). *Rec. Ind. Mus.* viii p. 47, pl. v, fig. 3, from Upper Rottung (Rottung village in East Siang district), Abor country (Abor Hills). Smith (1943) pp. 157-158 clubbed with *Elaphe mandarina* Cantor 1842.		
13.	*Ptyas korros* Schegel 1837	Throughout the state. Very common.	7 ex. in SFRI Museum: 2 ex. Itanagar, A. Borang; 3 ex. Chessa; 1 ex. Itanagar, K. Kaman; 1 ex. Itanagar, A. Captain
14.	*Ptyas nigromarginata* Blyth 1854	Throughout the state in the hill forests up to 2500 m.	1 ex. in SFRI Museum: Talley Valley, B.B. Bhatt
	Note: The first author has seen a dead snake run over by vehicle on the Pasighat-Pangin road about 5 km north of Regging village at about 400 m. The specimen could not be collected due to technical problems. Photograph was taken.		
15.	*Liopeltis frenata* Günther 1858	Throughout the state. Hills. 400-2000 m.	Annandale (1912a); Captain & Bhatt (2000).
	Note: Annandale (1912a), Mishmi Hills. *In*: *Rec. Ind. Mus.* viii, p. 47.		
16.	*Liopeltis stoliczkae* Sclater 1891	Throughout the state. Nearby hills stream. Not common	1 ex. in ZSI Itanagar: Ganga River (Itanagar), P.T. Bhutia
17.	*Oligodon albocinctus* Cantor 1839	Throughout the state. Common. Plains to 2000 m.	3 ex. in SFRI Museum: 2 ex. Chessa, K. Kaman; 1 ex. Gobuk, A. Borang
	Note: Wall (1909-1910), Sadia in and around Parbuk village. *In*: *J. Bombay Nat. Hist. Soc.* Part II, xix, p. 830.		
18.	*Oligodon cinereus* Günther 1864	Throughout the state. Plains to hills. Common.	4 ex. in SFRI Museum: 2 ex. Chessa, K. Kaman; 1 ex. Chessa; 1 ex. Chimpu, A. Borang
19.	*Oligodon erythrorhachis* Wall 1910	Foothills. Very Rare.	1 ex. in SFRI Museum 1 ex. Chessa, A. Borang
	Note: Known from 2 specimens (Bhatt *et al.* 1998); Wall (1910) *In*: *J. Bombay Nat. Hist. Soc. xix*. p. 923 and *Rec. Ind. Mus.* xxv. 1923, p. 309 (Namsang, Jaipur district, now Tinsukia district, Assam). The specimen under study was collected by the first author from a marshy nullah at Chessa, Papumpare district and is the first documented record from Arunachal Pradesh and second in the world.		
20.	*Dendrolaphis pictus* Gmelin 1789	Throughout the state. Plains to hills in busy forests. Very common.	7 ex. in SFRI Museum: 2 ex. Chessa, A. Borang; 3 ex. Chessa, K. Kaman; 2 ex. Pangge, B.B.Bhatt

Table 1: Systematic list of snakes in Arunachal Pradesh (*contd.*)

Sl. No.	Scientific Name	Distribution & Status	Remarks
21.	*Dendrolaphis cyanochloris* Wall 1921	Throughout the state. Plains to hills in bushy forests. Common.	1 ex. in Miao Forest Museum
	Note: In Wall (1909-1910) *Dendrolaphis proarchus* (*J. Bombay Nat. Hist. Soc.* Part II, xix, p. 827), Sadia in and around Parbuk village (Dibang Valley.)		
22.	*Dendrolaphis gorei* Wall 1910	Throughout the state. Plains to hills in bushy forests. Common.	2 ex. in SFRI Museum: 1 ex. Itanagar, J. Ali; 1 ex. Itanagar, D. Saikia
23.	*Chrysopelea ornata* Shaw 1802	Throughout the state. Plains to hills up to 2000 m. Very common in well wooded hill forests.	2 ex. in SFRI Museum: 1 ex. Damroh, A. Borang; 1 ex. Chessa, K. Kaman
24.	*Lycodon laoensis* Günther 1864	Throughout the state. Plains up to 1000 m.	1 ex. in Miao Forest Museum
25.	*Lycodon jara* Shaw 1802	Throughout the state. Foothills. Not common.	2 ex in SFRI Museum: 1 ex. Itangar, Donated by R.K.M. Hospital; 1 ex. Itanagar, B.B. Bhatt.
	Interesting Note: When disturbed the snake coiled into a ball-like shape and keeps motionless until it feels safe.		
26.	*Lycodon fasciatus* Anderson 1879	Throughout the state. Hill forests. 1000-2500 m.	1 ex. in SFRI Museum: Pangge, B.B. Bhatt.
27.	*Sibynophis collaris* Gray 1853	Throughout the state. High hills and montane forests Common in 1000-1500 m.	Captain & Bhatt (2000).
28.	*Amphiesma venningi* Wall 1910	Tirap and Changlang districts. High hills and montane forests. Common in 1000-1500 m.	Captain & Bhatt (2000, 2001)
29.	*Amphiesma parallelum* Boulenger, 1890	Throughout the state. High hills and montane forests. Common in 1500-2000 m.	2 ex. in SFRI Museum: 1 ex. Pangge, M.M. Borah; 1 ex. Pangge, B.B. Bhatt.
30.	*Amphiesma khasiensis* Boulenger 1890	Throughout the state. Not common.	Annandale (1912); Captain & Bhatt (2000).
	Note: Annandale (1912a), Upper Burma (Abor Country). *In*: *Rec. Ind. Mus.* viii. pp. 49 and 53.		
31.	*Amphiesma modesta* Günther 1875	Tirap district northwards Lohit district. Hills forests between 500-2000 m. Uncommon.	Ghosh (1987)
32.	*Amphiesma stolatum* Linnaeus 1758	Throughout the state. Plains to hills up to 2500 m. Very common.	6 ex. in SFRI Museum: 1 ex. Itanagar, A. Borang; 3 ex. Chessa, K. Kaman; 2 ex. Itanagar, A. Yirang.
33.	*Amphiesma platyceps* Blyth 1854	Throughout the state. Plains to hills up to 2500 m.	Annandale (1912); Pawar & Birand (2001).
	Note: Annandale (1912a), Abor Hills. *In*: *Rec. Ind. Mus.* viii, p. 49.		

Table 1: Systematic list of snakes in Arunachal Pradesh (*contd.*)

Sl. No.	Scientific Name	Distribution & Status	Remarks
34.	*Xenochrophis punctulatus* Günther 1958	Throughout the state. Plains to hills. Not common.	1 ex. in ZSI Museum: Itanagar, P.T. Bhutia
35.	*Xenochrophis piscator* Schneider 1799	Throughout the state. Plains and low altitude hills living in vicinity of water bodies. Common.	5 ex. in SFRI Museum: 2 ex. Itanagar, A. Borang, 3 ex. Chessa, K. Kaman
36.	*Xenochrophis sanctijohannis* Boulenger 1890	Throughout the state. Plains and hills up to 2000 m.	2 ex. in SFRI Museum: 1 ex. Shilluk, I. Dai; 1 ex. Shilluk, A. Borang
37.	*Sinonatrix percarinata* Boulenger 1899	Throughout the state. Well wooded wet hills preferably along the water course.	1. ex. in Miao Museum.
38.	*Rhadophis himalayanus* Günther 1864	Throughout the state. Foothills to hills up to 2000 m. Very Common.	9 ex. in SFRI Museum. 1 ex. Pangin; 1 ex. Boleng, A. Borang; 2 ex. Itanagar, K. Kaman; 2 ex. Itanagar, B.B. Bhatt; 2 ex. Chessa, Kancha Rai; 1 ex. Jumpa, K. Mitkong
	Note: Wall (1909-1910), *In*: *J. Bombay Nat. Hist. Soc.* Part I, xix, p. 614), Sadia in and around Parbuk village (Lower Dibang Valley) of Arunachal Pradesh.		
39.	*Rhadophis subminiatus* Schlegel 1837	Throughout the state. Foothills to hills. Very common.	8 ex. in SFRI Museum. 2 ex. Itanagar; 1 ex. Bijari, A. Borang; 3 ex. Itanagar; 1 ex. Seijusa, K. Kaman; 1 ex. Tippi, A.N. Rao
40.	*Pseudoxenodon macrops* Blyth 1854	Throughout the state. Plains to hills. Common in 1000-2500 m.	2 ex. in SFRI Museum: 1 ex. Chessa, A. Borang; 1 ex. Gate, B.B. Bhatt
41.	*Trachischium monticola* Cantor 1839	Throughout the state. Plains and hills. Very common in 1000-1500 m.	1 ex. SFRI Museum: Chessa, K. Kaman
42.	*Trachischium tenuiceps* Blyth 1854	North of R. Subansiri westwards Towang. Hills and montane forest montane forest up to 3000 m. Common.	2 ex. in ZSI Museum: 1 ex. Mukto (2500 m); 1 ex. Bomdir (2000 m); P.T. Bhutia
43.	*Rhabdops bicolor* Blyth 1854	Throughout the state. Common.	1 ex. in Miao Forest Museum
	Note: Wall (1925), *In*: *J. Bombay Nat. Hist. Soc.* xxx. p. 810 and *Ibid* xxx, 1926, p. 516, Upper Assam (Mishmi Hills and Khasi Hills).		
44.	*Blythia reticulata* Blyth 1854	Throughout the state. Foothills to hills. Common.	4 ex. in SFRI Museum: 2 ex. Itanagar, A. Borang; 2 ex. Chessa, K. Kaman
45.	*Boiga multimaculata* Reinwardt: Boie 1827	Throughout the state. Foothills and hills. Not common.	1 ex. in Miao Forest Museum

Table 1: Systematic list of snakes in Arunachal Pradesh (*contd.*)

Sl. No.	Scientific Name	Distribution & Status	Remarks
46.	*Boiga ochracae walli* Smith 1943	Throughout the state. Foothills and hills. Rare.	1 ex. in Miao Forest Museum
47.	*Boiga gokool* Gray 1834	Throughout the state. Foothills to hills. Common.	3 ex. in SFRI Museum: 1 ex. Seijusa, A. Borang; 2 ex. Itanagar, K. Kaman.
	Note: Wall (1909-1910), *In*: *J. Bombay Nat. Hist. Soc.* Part II xix. p. 831, Upper Assam (at Dejoo in and around Kimin, Papumpare district of Arunachal Padesh.)		
48.	*Boiga quincunciata* Wall 1908	Throughout the state. Foothills to hills.	2 ex. in SFRI Museum: 1 ex. Chessa, A. Borang; 1 ex. Itanagar, B.B. Bhatt
49.	*Boiga cyanea* Duméril, Bibron & Duméril 1854	Throughout the state. Foothills to hills.	2 ex. in SFRI Museum: 1 ex. Chessa, A. Borang; 1 ex. Itanagar, A. Yirang
50.	*Boiga ocellata* Kroon 1973	Throughout the state. Common.	4 ex. in SFRI Museum: 1 ex. Itanagar, A. Yirang; 3 ex. Chessa, K. Kaman
51.	*Psammodynastes pulverulentus* Boie 1827	Throughout the state. Plains and hills. Common in well wooded hills in wet areas.	2 ex. in SFRI Museum: 1 ex. Gobuk, A. Borang; 1 ex. Chimpu, K. Kaman
	Note: Wall (1909-1910), *In*: *J. Bombay Nat. Hist. Soc.* Part II xix. p. 833, Dejoo in and around Kimin, Papumpare district (originally recorded as Upper Assam).		
52.	*Ahaetulla prasina* Reinwardt: Boie 1827	Throughout the state. Plain to hills. Common in foothills.	2 ex. in SFRI Museum: 1 ex. Itanagar, A. Borang; 1 ex. Potin, B.B. Bhatt
	Note: Wall (1909-1910), *In*: *J. Bombay Nat. Hist. Soc.* Part II xix. p. 834. Daffla Hills in and around Dullungmukh, Lower Subansiri district, Dejoo in and around Kimin, Papumpare district and Sadia in and around Parbuk village, Lower Dibang Valley district (originally recorded as Upper Assam) of Arunachal Pradesh.		
	Subfamily: Homalopsinae		
53.	*Enhydris enhydris* Schneider 1799.	Throughout the state. Very common in open streams.	None in SFRI Museum but is the most common Water Snake.
	Family: Elapidae (Cobras, Kraits, Coral Snakes)		
54.	*Bungarus fasciatus* Schneider 1801	Throughout the state. Common in Bamboo forests.	7 ex. in SFRI Museum: 4 ex. Chessa,K. Kaman; 1 ex. Chessa, M. Pawe; 2 ex. Chessa, Kancha Rai
	Note: Wall (1909-1910), *In*: *J. Bombay Nat. Hist. Soc.* Part II xix. p. 835. Duffla Hills in and around Dullungmukh, Lower Subansiri district of Arunachal Pradesh.		
55.	*Bungarus niger* Wall 1908	Throughout the state. Not common.	2 ex. in ZSI, Itanagar; 2 ex. Itanagar, K. Allia
56.	*Bungarus lividus* Cantor 1839	Foothills of Kameng districts adjoining Assam.	Pawar & Birand (2001)

Table 1: Systematic list of snakes in Arunachal Pradesh (*contd.*)

Sl. No.	Scientific Name	Distribution & Status	Remarks
57.	*Sinomicrurus macclellandii* Reinhardt 1844	Throughout the state. Common.	5 ex. in SFRI Museum: 2 ex. Chessa, K. Kaman; 3 ex. Itanagar, A. Borang
	Note: Annandale (1912a), *In: Rec. Ind. Mus* viii, p. 50, Abor country (Abor Hills). Colour form I of Smith (1943) is most common in Arunachal Pradesh.		
58.	*Naja kaouthia* Lesson 1831	Throughout the state. Common.	3 ex. in SFRI Museum: 1 ex. Chessa,A. Borang; 2 ex. Itanagar, K. Kaman
59.	*Ophiophagus hannah* Cantor 1836	Throughout the state. Common.	3 ex. in SFRI Museum: 1 ex. Chessa, V.V.K. Chessa Labour Party; 1 ex. Itanagar, B.B. Bhatt; 1 ex. Itanagar, A. Captain
	Family: Viperidae (True Vipers & Pit Vipers) **Subfamily**: Crotalinae (Pit Vipers)		
60.	*Protobothrops mucrosquamatus* Cantor 1839	Throughout the state. In hills. 1000-3000 m.	2 ex. in SFRI Museum: 1 ex. Gate; 1 ex. Ziro, B.B. Bhatt
61.	*Protobothrops jerdoni* Gunther, 1875	Hills and Montane forests. 1000-3000 m.	Captain & Bhatt (2000)
62.	*Ovophis monticola* Günther 1864	Throughout the state. In hills. Common at 1000-3000 m.	1 ex. in ZSI, Itanagar: Mehao, T.K. Pal
63.	*Trimeresurus stejnegeri* Schmidt 1925	Throughout the state. Plains to moist montane bamboo forests.	1 ex. in Itanagar Zoo
	Note: Absence of hemipenis, female. Scale formula, 21: 11: 163: 58. Temporal scale are feebly keeled hence is provisionally identified as *Trimeresurus stejnegeri* (*Trimeresurus stejnegeri yunnanensis* ?) Schmidt 1925. (see Das 1996). The subspecies is now *Trimerusurus stejnegeri* Schmidt 1925 and *Trimerusurus yunnanensis* Schmidt 1925 (see David et *al.* 2001).		
64.	*Trimeresurus popeiorum* Smith 1937	Throughout the state. Plains to moist montane bamboo forests.	1 ex. in SFRI Museum: Pangin, A. Borang
65.	*Trimeresurus erythrurus* Cantor 1839	Tirap district northwards (with population thinning down) to Changlang district.	
	Note: It is very common in Naga Hills (Smith 1943). Personal contact with local people in Khonsa (Titap district) during 1997 reveals occurrence of similar snake with tail mottled with red (brown). Also (Patrick David *pers. comm.*, 2002).		
66.	*Trimeresurus albolabris* Gray 1842	Throughout the state. Plains and low altitude hills. forests.	1 ex. in SFRI Museum: Chessa, K. Kaman
67.	*Trimeresurus medoensis* Djao: Djao & Jiang 1977	Extreme eastern part of Changlang district adjoining to Myanmar. Wet montane forests above 1500 m.	David et *al.* (2001); Captain & Bhatt (2000).
	Note: Reported from Gandhigram in Changlang district based on examination on 26 live specimens David et *al.* (2001). Its occurrence is restricted to the northeastern part of Arunachal Pradesh in India. Probably occurs in Kepang La, Karbo, Gelling and Singa areas in Upper Siang district. New to the Indian fauna.		

SFRI Museum: State Forest Research Institute Museum, ZSI: Zoological Survey of India, VVK: Van Vigyan Kendra

Specimens not identified

1. *Trimeresurus* sp. (*T. stejnegeri* Schmidt 1925 or *T. popeiorum* Smith 1939); Scale count - 21: 11: 167: 61; dorsal scales moderately keeled; scale between supra-ocular 13 narrow; 2 rows of scales between labials and elongated sub-ocular. Collected by K. Haridasan from Chessa (100 m).

2. Unidentified Keelback species: 2 pre-oculars; 3 post-oculars; 8L, 7R supralabials; 2+2 temporals; 1 large loreal; scale in 17: 17: 15 rows keeled; 165 ventrals; 61 caudal paired; 2 anals. Collected about 10 km east of Pangge at 2000 m on 14.vi.1994 by the first author. Could not be identified from Smith (1943); perhaps not described from India.

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REFERENCES

Annandale, N. (1911): Contribution to the Fauna of Yunnan, based on collection made by J. Coggin, B.Sc., 1909-1910. Part VI. Batrachia and Reptiles. *Rec. Ind. Mus.* VI, pp. 215-218.

Annandale, N. (1912a): Zoological Result of Abor Expedition, 1911-12: II. Reptilia. *Rec. Ind. Mus.* VIII: 37-55.

Annandale, N. (1912b): Zoological Result of Abor Expedition, 1911-12: II. Reptilia. *Rec. Ind. Mus.* Supplement, VIII, pp. 357-358.

Bhatt, B.B., A.S. Captain & A. Borang (1998): On the occurrence of a rare snake in Arunachal Pradesh. *The Indian Forester 124(2)*: 169-171.

Cantor, Th. (1839): Spicilegium Serpentium. *Proc. Zool. Soc. London.* Pp. 31-34. 49-55/ Col. Sketches and MS in Radcliffe Library, Oxford.

Captain, A. (1997): A Catalogue of most of the Snakes preserved by various Institutions in Itanagar, Arunachal Pradesh, India. (Unpublished)

Captain, A. (1999): Recent Distributional Records of Snakes from Arunachal Pradesh, India (1996-1999). (Unpublished)

Captain, A. & B.B. Bhatt (1997): Some snakes of the Itanagar area of Papumpare district, Arunachal Pradesh. *Arunachal For. News 15 (1 & 2)*: 12-14.

Captain, A. & B.B. Bhatt (2000): An interim checklist of the snakes of Arunachal Pradesh. *The RFNEI Newsletter 3*: 10-13.

Captain, A. & B.B. Bhatt (2001): First records of *Amphiesma venningi* (Wall, 1910) (Serpentes, Colubridae, Natricinae) from India, with remarks on its subspecies. *Hamadryad 26(2)*: 354-358.

Das, I. (1994): The Reptiles of South Asia: Checklist and distributional summary. *Hamadryad 19*: 15-40.

Das, I. (1996): Biogeography of the Reptiles of South Asia. Krieger Publishing Company, Malabar, Florida. Pp. vii+86 pp., 36 pl.

Das, I. (1997): Checklist of reptiles of India with English common names. *Hamadryad 22*: 32-45.

David, P., A. Captain & B.B. Bhatt (2001): On the occurrence of *Trimeresurus medoensis* Djao. In: Djao & Jiang, 1977 (Serpentes, Viperidae, Crotalinae) in India, with a redescription of this species and notes on its biology. *Hamadryad 26(2)*: 210-226.

Ghosh, A.K. (1987): Qualitative analysis of faunal resources: proposed Namdapha Biosphere Reserve, Arunachal Pradesh. Zoological Survey of India, Calcutta. Pp. 268.

Gupta, Brij & S. Rathanasabathy (1997): Checklist of reptiles of India with respect to the Wildlife Act, 1991, from a checklist compiled by Indraneil Das, Harry Andrews. *Zoos' Print 12(6)*: 21-30.

Mathew, R. (1983): On a collection of snakes from northeast India (Reptilia: Serpentes). *Rec. zool. Surv. India 80*: 449-458.

Mathew, R. (1995): Reptilia. Pp. 379-454. *In*: Fauna of Meghalaya, Part I. State Fauna Series 4. Vertebrates (Ed. Ghosh, A.K.). Zoological Survey of India, Calcutta.

Pawar, Samraat & Aysegul Birand (2001): A Survey of Amphibians, Reptiles and Birds in Northeast India. CERC Technical Report: 6. Centre for Ecological Research and Conservation, Mysore. 118 pp.

Romer, J.D. (1949): Herpetological observation in Assam and Bengal (1944). *J. Bombay Nat. Hist. Soc. 48*: 376-387.

Sanyal, D.P. & N.C. Gayen (1985): Reptilia. Pp. 297-302. *In*: Fauna of Namdapha: Proposed Biosphere Reserve. *Rec. zool. Surv. India 82(1-4)*. Zoological Survey of India, Calcutta.

Smith, M.A. (1943): The Fauna of British India, Ceylon and Burma including the whole of the Indo-Chinese sub-region. Reptilia and Amphibia. Vol. III. Serpentes. Taylor & Francis, London xii + 583 pp.

Wall, F. (1909-1910): Notes on snakes collected in Upper Assam. Part I, *J. Bombay Nat. Hist. Soc. xix*: 608-623; Part II, *J. Bombay Nat. Hist. Soc. xix*: 825-845.

Wall, F. (1910): A new snake from Assam (*Oligodon erythrorachis*). *J. Bombay Nat. Hist. Soc. xix*: 923-924.

Waltner, R.G. (1975a): Geographical and Altitudinal distribution of Amphibians and Reptiles in the Himalayas. Part I. *Cheetal 16*: 17-25.

Waltner, R.G. (1975b): Geographical and Altitudinal distribution of Amphibians and Reptiles in the Himalayas. Part II. *Cheetal 16*: 28-36.

Waltner, R.G. (1975c): Geographical and Altitudinal distribution of Amphibians and Reptiles in the Himalayas. Part III. *Cheetal 16*: 14-19.

Waltner, R.G. (1975d): Geographical and Altitudinal distribution of Amphibians and Reptiles in the Himalayas. Part IV. *Cheetal 16*: 12-17.

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COMMUNITY STRUCTURE OF AMPHIBIANS AT THREE PROTECTED AREAS OF KERALA[1]

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The community structure of amphibian assemblages in three protected areas of Kerala – Peppara Wildlife Sanctuary, Periyar Tiger Reserve and Agasthyavanam Biological Park – has been studied. Population census, diversity, evenness, richness, ecological distribution, niche breadth and niche overlap of amphibians were determined. There was high species diversity at all the sites. More than one female was available for each male of all the species. The amphibian community was evenly distributed at each area. Niche breadth was high in Agasthyavanam Biological Park, followed by Periyar Tiger Reserve and Peppara Wildlife Sanctuary. Niche overlap values indicate that the amphibian communities in the three protected areas show great ecological similarity among sympatric species.

Key words: Amphibians, community structure, protected areas, Kerala

INTRODUCTION

Amphibians, particularly frogs and toads, in many widely separated parts of the world appear to be declining (Barinaga 1990; Wake 1991). The most predominant factor responsible for the decline is anthropogenic activities, which result in shrinkage of habitats where amphibians are found. Several studies have been made on amphibian communities in different ecosystems. Niche overlap and interspecific competition in three species of *Rana* in Sarawak have been reported by Inger and Greenberg (1966). Inger (1969) also studied the organisation of communities of frogs in lowland streams in Sarawak. Crump (1971) made a quantitative analysis of ecological distribution of tropical herpetofauna. Densities of floor dwelling frogs in lowland forests of southeast Asia and Central America have been studied by Inger (1980). Inger and Voris (1993) made a comparative study on the Bornean amphibian communities. Resource utilisation by the amphibian community in Borneo has been reported by Das (1996a). Similar studies are few in India (Inger *et al.* 1987; Dash and Mahanta 1993; Das 1996b; Vasudevan *et al.* 2001).

Recently, importance is being given to the conservation of amphibians and to the study of environmental resource utilisation by different species. Kerala has a diverse amphibian fauna (Andrews and George 1998). However, there is little data on the amphibian community's function, which is important for conservation (Inger *et al.* 1987; Dash and Mahanta 1993). The present study was designed to analyse the community structure of amphibians in three protected areas in the Kerala part of the Western Ghats.

MATERIAL AND METHODS

Studies on the community structure of amphibian assemblages at Peppara Wildlife Sanctuary (moist deciduous forest), Periyar Tiger Reserve (semi-evergreen forest) and Agasthyavanam Biological Park (evergreen forest) have been carried out from 2000-2001. Each study site was divided into quadrats of dimensions 50 m x 50 m. The quadrats were demarcated on the selected forest floor and searched thoroughly in such a way that the escape of amphibians from the area was impeded. At all sites, the search for amphibians was done from one end to another of each quadrat at a stretch. Logs were shifted and examined thoroughly, rocks overturned, litter raked and the vegetation examined. Sampling in each quadrat was done for 6 hours daily (0600 to 0900 hrs and 1700-2000 hrs) for two weeks each at Peppara Wildlife Sanctuary (6 quadrats – 3 riparian and 3 non-riparian), Periyar Tiger Reserve (8 quadrats – 3 riparian and 5 non-riparian) and Agasthyavanam Biological Park (3 quadrats – all non-riparian) by two persons using collecting nets and large torches. Frogs/ toads captured were identified, measured and released as per the standard methods for amphibians (Heyer *et al.* 1994). Population census, diversity, evenness, richness, ecological distribution, niche breadth and niche overlap of amphibians at all the three sites were studied using the following formulae (Krebs 1999).

1. **Simpson's index of diversity**:

$$I\text{-}D = I - \sum(P_i)^2$$

$I\text{-}D$ = Simpson's index of diversity
P_i = Proportion of individuals of species 'i' in the community

2. **Shannon-Weiner diversity**:

$$H' = \sum_{i=1}^{s}(P_i)\ (\log 2\ P_i)$$

H' = Index of species diversity
s = Number of species
P_i = Proportion of total sample belonging to ith species

3. **Brillouin's diversity**:

$$\hat{H} = \frac{1}{N} \log\left(\frac{N!}{n_1!\, n_2!\, n_3!....}\right)$$

$\hat{H}$ = Brillouin's diversity
N = Total number of individuals in entire collection
$n_1!$ = Number of individuals belonging to species 1
$n_2!$ = Number of individuals belonging to species 2
$n_3!$ = Number of individuals belonging to species 3

4. **Smith and Wilson's measure of evenness**:

$$E_{var} = 1 - \left[\frac{2}{\pi \arctan\left\{\sum_{i=1}^{s}\left(\log_e(n_i) - \sum_{j=1}^{s}\log_e\left(n_j/s\right)\right)^2 / S\right\}}\right]$$

E_{var} = Smith and Wilson's index of evenness
n_i = Number of individuals in species i in species (i = 1,2,3...)
n_j = Number of individuals in species j in species (j = 1,2,3...)
S = Number of species in entire collection

5. **Levins's measure of niche breadth**:

$$B = \frac{y^2}{\Sigma N_{j^2}}$$

B = Levin's measure of niche breadth
N_j = Number of individuals found in or using resource state j
y = Total number of individuals sampled

6. **Jackknife estimate of species richness**:

$$S' = s + \left(\frac{n-1}{n}\right) k$$

S' = Jackknife's estimate of species richness
s = Observed total number of species present in n quadrat
n = Total number of quadrat samples
k = Number of unique species

7. **Horn's index of niche overlap**:

$$R_0 = \frac{\Sigma(P_{ij} + P_{ik}) \log (P_{ij} + P_{ik}) - \Sigma P_{ij} \log P_{ij} - \Sigma P_{ik} \log P_{ik}}{2 \log 2}$$

R_0 = Horn's index
P_{ij} = Proportion resource i is of the total resources utilized by species j
P_{ik} = Proportion resource i is of the total resources utilized by species k

RESULTS AND DISCUSSION

Table 1 provides data on population density of amphibians at three protected areas of Kerala. Of the 17 species of amphibians recorded, 12 species each were recorded from Peppara Wildlife Sanctuary and Periyar Tiger Reserve, while five species were collected from Agasthyavanam Biological Park. Population density of *Rana temporalis* was found to be high in all the three protected areas. At Peppara Wildlife Sanctuary, *Rana temporalis* alone contributed 44% to the total diversity. At Periyar Tiger Reserve and Agasthyavanam Biological Park, *R. temporalis* constituted 40.7 and 41.46% of the total diversity, respectively (Table 2). *Philautus pulcherrimus* and *Rhacophorus malabaricus* were found to be the rarest species in the present study. For all the species, more than one female was available for each male. The sex ratio was maximum in *Rana temporalis* and minimum in *Rhacophorus malabaricus* (Table 3).

The analysis of dominance, diversity and evenness indices provide valuable quantitative information in different

Table 1: Population density of amphibians at three protected areas of Kerala

Sl. No.	Species	Peppara Wildlife Sanctuary	Periyar Tiger Reserve	Agasthyavanam Biological Park
1	*Bufo melanostictus*	1.5	1.5	0.7
2	*Euphlyctis cyanophlyctis*	0.5	0.9	-
3	*E. hexadactylus*	1.5	-	-
4	*Limnonectes keralensis*	1.7	1.0	2.3
5	*L. limnocharis*	0.5	2.5	-
6	*L. nilagirica*	-	0.6	-
7	*Rana temporalis*	9.2	7.6	4.0
8	*Rana curtipes*	-	0.4	-
9	*Nyctibatrachus major*	0.7	0.5	1.7
10	*N. minor*	0.7	-	-
11	*Microhyla ornata*	-	0.8	-
12	*Micrixalus fuscus*	-	0.5	1.0
13	*Philautus variabilis*	3.5	2.5	-
14	*P. pulcherrimus*	0.2	-	-
15	*Polypedates pseudocruciger*	0.8	0.3	-
16	*Rhacophorus malabaricus*	0.2	-	-

Table 2: Percentage occurrence of amphibians at three protected areas of Kerala

Sl. No.	Species	Peppara Wildlife Sanctuary	Periyar Tiger Reserve	Agasthyavanam Biological Park
1	*Bufo melanostictus*	7.2	8.0	6.9
2	*Euphlyctis cyanophlyctis*	2.4	4.7	-
3	*E. hexadactylus*	7.2	-	-
4	*Limnonectes keralensis*	8.0	5.3	24.1
5	*L. limnocharis*	2.4	13.3	-
6	*L. nilagirica*	-	3.3	-
7	*Rana temporalis*	44.0	40.7	41.46
8	*Rana curtipes*	-	2.0	-
9	*Nyctibatrachus major*	3.2	2.7	17.24
10	*N. minor*	3.2	-	-
11	*Microhyla ornata*	-	4.0	-
12	*Micrixalus fuscus*	-	2.7	10.3
13	*Philautus variabilis*	16.8	12.0	-
14	*P. pulcherrimus*	0.8	-	-
15	*Polypedates pseudocruciger*	4.0	1.3	-
16	*Rhacophorus malabaricus*	0.8	-	-

Table 3: Male-Female ratio of amphibians at three protected areas of Kerala

Sl. No.	Species	Peppara Wildlife Sanctuary	Periyar Tiger Reserve	Agasthyavanam Biological Park
1	*Bufo melanostictus*	2.33	1.84	2.11
2	*Euphlyctis cyanophlyctis*	1.93	1.72	-
3	*E. hexadactylus*	2.14	-	-
4	*Limnonectes keralensis*	2.57	1.78	2.25
5	*L. limnocharis*	2.36	3.22	-
6	*L. nilagirica*	-	0.16	-
7	*Rana temporalis*	4.89	5.22	4.92
8	*Rana curtipes*	-	1.89	-
9	*Nyctibatrachus major*	1.09	1.39	1.27
10	*N. minor*	1.18	-	-
11	*Microhyla ornata*	-	0.52	-
12	*Micrixalus fuscus*	-	1.29	1.39
13	*Philautus variabilis*	2.27	2.12	-
14	*P. pulcherrimus*	0.49	-	-
15	*Polypedates pseudocruciger*	2.13	1.89	-
16	*Rhacophorus malabaricus*	0.05	-	-

habitats. For the analysis of dominance, three indices were used in the present study. Simpson's diversity index was found to be 0.763 (Peppara) 0.792 (Periyar) and 0.751 (Agasthyavanam), which indicates a high species diversity in all the protected areas. Shannon-Wiener's diversity does not seem to exceed 5.0 for most of the biological communities. In the present study also, the values are within the limits and show high diversity. Brillouin's index is used when the sampling is done without replacement. It is practically identical to Shannon-Wiener index. In the present study too, diversity was found to be high (Table 4). At Peppara, *Rana temporalis* and *Philautus variabilis* contributed 60.8% of the total diversity index value. At Periyar, *Rana temporalis*, *Limnonectes limnocharis* and *Philautus variabilis* constituted 66% of the index value while at Agasthyavanam, *Rana temporalis, Limnonectes keralensis* and *Nyctibatrachus major* contributed 82.8% of the index value (Table 2).

The distribution of amphibians in the three protected areas was found to be even (Table 4). Amphibian community at Agasthyavanam Biological Park was most evenly distributed, followed by Periyar Tiger Reserve and Peppara Wildlife Sanctuary. Estimated species richness of the 12 species reported from Peppara was 16.2 with a confidence limit of 7.8 to 24.6. Five species were found to be unique in the area. At Periyar Tiger Reserve, estimated species richness was 16.4 with five unique species. At Agasthyavanam Biological Park, the estimated species richness was 6.3 with

Table 4: Estimation of species diversity, evenness, richness and niche breadth of amphibian populations at three protected areas of Kerala

Parameters	Peppara Wildlife Sanctuary	Periyar Tiger Reserve	Agasthyavanam Biological Park
Species Diversity			
Simpson's Diversity (I-D)	0.763	0.792	0.751
Shannon-Wiener's Diversity (H')	2.665	2.830	2.064
Brillouin's Diversity (H)	2.445	2.637	1.765
Evenness measure			
Smith and Wilson's Evenness measure	0.436	0.560	0.761
Species richness			
Estimated species Richess (Jackknife Method)	16.2 + 3.27	16.4 + 2.63	6.3 + 1.33
No. of unique species	5	5	2
Niche breadth			
Levin's standardised niche breadth	0.535	0.565	0.740
No. of frequently used resources	5/8	4/5	5/6

two unique species. The ecological distribution and the relative abundance of each species were studied at all sites. The resource states based on microhabitat preference were divided into eight subgroups at Peppara Wildlife Sanctuary such as in water, on bare soil, dead leaves, rocks, logs, herbs, shrubs and trees. The distribution of amphibians within the six quadrats was found as 38 individuals/6 species in water, 20/6 on bare soil, 7/3 on dead leaves, 1/1 on rocks, 2/1 on logs, 28/2 on herbs, 23/3 on shrubs and 5/3 on trees. At Periyar Tiger Reserve, the microhabitats were divided into five subgroups, namely in water, on grass, bare soil, dead leaves and rocks. The amphibians within the 8 quadrats were distributed as 19 individuals/4 species in water, 66/7 on grass, 27/6 on bare soil, 32/4 on dead leaves and 5/2 on rocks. At Agasthyavanam Biological Park, the microhabitats were divided into six subgroups such as in water, on bare soil, shrubs, sand and rocks. The distribution of amphibians within the 3 quadrats was found as 5 individuals/2 species in water, 3/1 on grass, 5/3 on bare soil, 3/3 on rocks, 1/1 on sand and 4/1 on shrubs.

Niche breadth measurement is used to find out how organisms utilise their environment. It was measured by observing the distribution of individuals within a set microhabitats. Table 4 gives the Levin's standardised niche breadth scores for the amphibian communities at three protected areas. Niche breadth score was found to be high in Agasthyavanam Biological Park, followed by Periyar Tiger Reserve and Peppara Wildlife Sanctuary. It indicates that habitat generalists were abundant in Agasthyavanam and Periyar since the frequently used microhabitats by amphibians were five out of six and four out of five respectively. At Peppara, frequently used microhabitats were five out of eight, indicating the presence of habitat specialists.

Niche overlap (Horn's index) is a measure of the association of two or more species. The minimum and maximum niche overlap values are 0 and 1 respectively. A value of zero indicates no overlap and 1 indicates 100% overlap (Inger and Colwell 1977). In the present study, *Euphlyctis hexadactylus / Euphlyctis cyanophlyctis* and *Rhacophorus malabaricus / Philautus pulcherrimus* showed 100% overlap value at Peppara which indicates that they are found together more often than other species in the area (Table 5a). At Peppara, among the 12 species recorded, *Rana temporalis* was found sharing the microhabitat with nine other species, with varying degrees of overlap. This was followed by *Limnonectes keralensis* and *Nyctibatrachus minor* with 8 species. *Philautus pulcherrimus*, *Polypedates pseudocruciger* and *Rhacophorus malabaricus* were found to be the least associated, their association for the microhabitat being limited to two species.

At Periyar Wildlife Sanctuary, *Rana curtipes / Limnonectes limnocharis* and *Euphlyctis cyanophlyctis / Nyctibatrachus major* were found to be more associated (Table 5b). Here *Rana temporalis* was found to share the microhabitat with all the other species, with varying degrees of overlap followed by *Limnonectes nilagirica, Microhyla ornata* and *Bufo melanostictus* with eight species. *Micrixalus fuscus* was the least associated species, its association for the microhabitat being limited to one species.

At Agasthyavanam Biological Park, 100% overlap was not found between any of the five species recorded. However, the maximum overlap was found between *Limnonectes*

Table 5a: Niche overlap of amphibians at Peppara Wildlife Sanctuary (Horn's index)

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.000	0.000	0.878	0.925	0.000	0.612	0.000	0.000	0.000	0.000	0.146
2	0.000	1.000	1.000	0.242	0.000	0.862	0.689	0.000	0.000	0.000	0.000	0.581
3	0.000	1.000	1.000	0.242	0.000	0.862	0.689	0.000	0.000	0.000	0.000	0.581
4	0.878	0.242	0.242	1.000	0.948	0.222	0.629	0.000	0.000	0.000	0.000	0.240
5	0.925	0.000	0.000	0.948	1.000	0.000	0.000	0.451	0.000	0.000	0.000	0.065
6	0.000	0.862	0.862	0.222	0.000	1.000	0.607	0.000	0.000	0.000	0.000	0.517
7	0.612	0.689	0.689	0.629	0.451	0.607	1.000	0.000	0.000	0.000	0.000	0.517
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.311	0.378	0.311	0.621
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.311	1.000	0.000	1.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.378	0.000	1.000	0.000	0.451
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.311	1.000	0.000	1.000	0.000
12	0.146	0.581	0.581	0.240	0.065	0.517	0.580	0.621	0.000	0.451	0.000	1.000

1. *Bufo melanostictus*, 2. *Euphlyctis cyanophlyctis*, 3. *E. hexadactylus*, 4. *Limnonectes keralensis*, 5. *L. limnocharis*, 6. *Nyctibatrachus major*, 7. *N. minor*, 8. *Philautus variabilis*, 9. *P. pulcherrimus*, 10. *Polypedates pseudocruciger*, 11. *Rhacophorus malabaricus*, 12. *Rana temporalis*

Table 5b: Niche overlap of amphibians at Periyar Wildlife Sanctuary (Horn's index)

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.572	0.418	0.904	0.572	0.847	0.693	0.205	0.311	0.768	0.205	0.059
2	0.572	1.000	0.000	0.764	1.000	0.809	0.809	0.000	0.000	0.541	0.000	0.000
3	0.418	0.000	1.000	0.338	0.000	0.000	0.459	0.541	0.809	0.623	0.541	0.000
4	0.904	0.764	0.338	1.000	0.764	0.887	0.887	0.000	0.390	0.884	0.000	0.000
5	0.572	1.000	0.000	0.764	1.000	0.809	0.809	0.000	0.000	0.541	0.000	0.000
6	0.847	0.809	0.000	0.887	0.809	1.000	0.667	0.000	0.000	0.610	0.000	0.000
7	0.693	0.809	0.459	0.887	0.809	0.667	1.000	0.000	0.541	0.893	0.000	0.000
8	0.205	0.000	0.541	0.000	0.000	0.000	0.000	1.000	0.000	0.000	1.000	0.000
9	0.311	0.000	0.809	0.390	0.000	0.000	0.541	0.000	1.000	0.752	0.000	0.000
10	0.768	0.541	0.623	0.884	0.541	0.610	0.893	0.000	0.752	1.000	0.000	0.000
11	0.205	0.000	0.541	0.000	0.000	0.000	0.000	1.000	0.000	0.000	1.000	0.000
12	0.059	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

1. *Rana temporalis*, 2. *R. curtipes*, 3. *Limnonectes keralensis*, 4. *L. nilagirica*, 5. *L. limnocharis*, 6. *Philautus variabilis*, 7. *Microhyla ornata*, 8. *Euphlyctis cyanophlyctis*, 9. *Polypedates pseudocruciger*, 10. *Bufo melanostictus*, 11. *Nyctibatrachus major*, 12. *Micrixalus fuscus*

Table 5c: Niche overlap of amphibians at Agasthyavanam Biological Park (Horn's index)

	1	2	3	4	5
1	1.000	0.413	0.212	0.255	0.000
2	0.413	1.000	0.925	0.168	0.000
3	0.212	0.925	1.000	0.000	0.000
4	0.255	0.168	0.000	1.000	0.764
5	0.000	0.000	0.000	0.764	1.000

1. *Rana temporalis*, 2. *Limnonectes keralensis*, 3. *Bufo melanostictus*, 4. *Nyctibatrachus major*, 5. *Micrixalus fuscus*

keralensis and *Bufo melanostictus* (Table 5c). Here, *Rana temporalis*, *Limnonectes keralensis* and *Nyctibatrachus major* were found to share the microhabitat with three other species, followed by *Bufo melanostictus* with two species and *Micrixalus fuscus* with one species.

CONCLUSION

It was evident from the present study that the amphibian communities in the three protected areas of Kerala show greater ecological similarity (greater niche overlap) among co-existing species. Such similarities are already established for amphibian communities from tropical rain forests (Inger and Colwell 1977). It is assumed that if overlap should be greater, more species share a given variety of resources, in the absence of compensating differences in niche breadth. Resource use by ecologically more similar pairs of species is more likely to be subject to evolutionary adjustments through the combined effects of competition and environmental fluctuations (Inger and Colwell 1977). However, no such conclusion is possible in the absence of earlier studies in this region.

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REFERENCES

ANDREWS, M.I. & S. GEORGE (1988): Amphibian resources of Kerala. *Cobra 33*: 41-48.

BARINAGA, M. (1990): Where have all froggies gone. *Science 247*: 1033-1034.

CRUMP, M.L. (1971): Quantitative analysis of the ecological distribution of a tropical herpetofauna. *Museum Nat. Hist. Univ. Kansas Publ. 3*: 31-62.

DAS, I. (1996a): Spatio-temporal resource utilization by a Bornean rain forest herpeto anura: preliminary results. Pp. 315-323. *In*: Tropical Rainforests Research Current Issues (Eds: Edwards, D.S., W.E. Booth and S.C. Choy), Kluwer Academic Publishers, Dordrecht. Pp 315-323.

DAS, I. (1996b): Resource use and foraging tactics in a south Indian anuran community. *J. South Asian nat. Hist. 2(1)*: 1-30.

DASH, M.C. & J.K. MAHANTA (1993): Quantitative analysis of the community structure of tropical amphibian assemblages and its

significance to conservation. *J. Biosci. 18(1)*: 121-139.

HEYER, W.R., M.A. DONNELLY, R.W. MCDIARMID, L.C. HAYEK & M.S. FISTER (1994): Measuring and monitoring biological diversity - methods for amphibians. Smithsonian Institution Press, Washington D.C., pp. 690.

INGER, R.F. (1969): Organization of communities of frogs along small rain forest streams in Sarawak. *J. Anim. Ecol. 38*: 123-148.

INGER, R.F. (1980): Densities of floor dwelling frogs and lizards in lowland forests in southeast Asia and central America. *Amer. Nat. 115*: 761-770.

INGER, R.F. & R.K. COLWELL (1977): Organization of contiguous communities of amphibians and reptiles in Thailand. *Ecol. Monogr. 47*: 229-253.

INGER, R.F. & B. GREENBERG (1966): Ecological and competitive relations among three species of frogs (Genus *Rana*). *Ecol. 47*: 746-759.

INGER, R.F., H.B. SHAFFER, M. KOSHY & R. BAKDE (1987): Ecological structure of a herpetological assemblage in South India. *Amphibia Reptilia 8*: 189-202.

INGER, R.F. & H.K. VORIS (1993): A comparison of amphibian communities through time and from place to place in Bornean forests. *J. Trop. Ecol. 9*: 409-433.

KREBS, C.J. (1999): Ecological methodology. Addison-Wesley Educational Publishers, Inc. Pp. 410-475.

VASUDEVAN, K., A. KUMAR & R. CHELLAM (2001): Structure and composition of rain forest floor amphibian communities in Kalakad-Mundathurai Tiger Reserve. *Curr. Sci. 80(3)*: 406-412.

WAKE, D.B. (1991): Declining amphibian populations. *Science 253*: 860.

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BIOLOGY OF MALABAR BANDED SWALLOWTAIL *PAPILIO LIOMEDON* MOORE[1]

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The biology of the Malabar Banded Swallowtail *Papilio liomedon* Moore on a new larval food plant was recorded and the larval food plant investigated. The life cycle, brood size, larval instar duration, pupae and sex ratio were observed.

Keywords: Life cycle, new host plant, Malabar Banded Swallowtail, *Papilio liomedon* Moore, endemic butterfly, Western Ghats

INTRODUCTION

The Malabar Banded Swallowtail *Papilio liomedon* Moore, a large, brownish-black butterfly, with a prominent cream yellow band on its wing, is among the rarest of papilionid butterflies of southern India. It is endemic to the Western Ghats and an inhabitant of semi-evergreen and evergreen forests. It normally flies high in the dense forest, but is attracted to clearings and roadsides, where its adult-food plants, *Clerodendron paniculatum*, *C. infortunatum* and *Stachytrapheta indica* grow. It is not unusual to find specimens flying even in heavy rain. Over forest paths, particularly during monsoon, this powerful flier is seen flying fast with rapid wing beats. It is easier to approach while mud puddling.

Achronychia laurifolia Blume (Family Rutaceae) is the recorded larval food plant of the Malabar Banded Swallowtail. *Achronychia laurifolia* is not a widely distributed species and is seen in semi-evergreen and evergreen forests. The new food plant reported in this paper, Indian Aspen *Evodia roxburghiana* also belongs to Family Rutaceae. This tree occurs in deciduous, semi-evergreen and evergreen forests all over India. *Evodia roxburghiana* is also seen at an elevation of 1,886 m in the Agasthyakoodam peak, Neyyar Wildlife Sanctuary, Thiruvananthapuram.

STUDY AREA AND METHODOLOGY

The study was carried out in the Arippa Ammayambalam pacha, lying within 77° 1' 45" - 77° 2' 50" E and 8° 49' - 8° 35' N, lowland evergreen forests of the Western Ghats, in Kulathupuzha reserve forests, 52 km from Thiruvananthapuram.

Observations on the biology of the Malabar Banded Swallowtail *Papilio liomedon* Moore have been made since 1996 under semi natural conditions. Eggs collected from the tender shoots of *Evodia roxburghiana* were transferred to cylindrical glass jars, 22 cm tall and 10 cm wide, with a capacity of 2 litres, partially immersed in a tray of water kept in a cool place. Number of eggs/brood, hatching period, duration of larval instars, mode of larval feeding, pupation and metamorphosis were noted. Sex ratio after emergence, natural predators, number of unhatched eggs, number of diseased larvae, and other factors were noted. Number of eggs/brood, hatching rate, pupation rate, and metamorphosis rate were also observed under natural conditions. Using this data, the life cycle (Table 1) of the Malabar Banded Swallowtail *Papilio liomedon* Moore was worked out.

RESULTS AND DISCUSSION

Egg

The female lays about 16 eggs one over the other like a stick on tender shoots of *Evodia roxburghiana* (Fig. 1A). No visible change was observed in the eggs for three days. The orange eggs gradually faded to yellow. Pale black markings appeared on the upper side of the egg shell on the fourth day. On closer observation through a magnifying glass, the black spots were identified as the heads of the larvae.

I[st] Instar

On the fifth day, the larvae emerged from the eggs. The outermost egg hatched first and the egg nearest the tender shoot hatched last. After eating the eggshells, the larvae congregated at the bottom of the leaf. The newly hatched 3 mm long larva was orange with a black head. The body was covered with tiny hairs. On the second day after emergence, the larvae began to feed on tender leaves. They ate the edges of the leaves and made small circles on tender leaves. Each grew to about 6 mm. The hair covering the body disappeared by the third day. The larvae now produced tiny silken threads by which they hung on leaves. The larvae congregated on the upperside of the leaves. Each one grew 7 mm long. On the fifth day the larvae seemed less active. When alarmed due to any movement in the leaves, the larvae raised their heads and

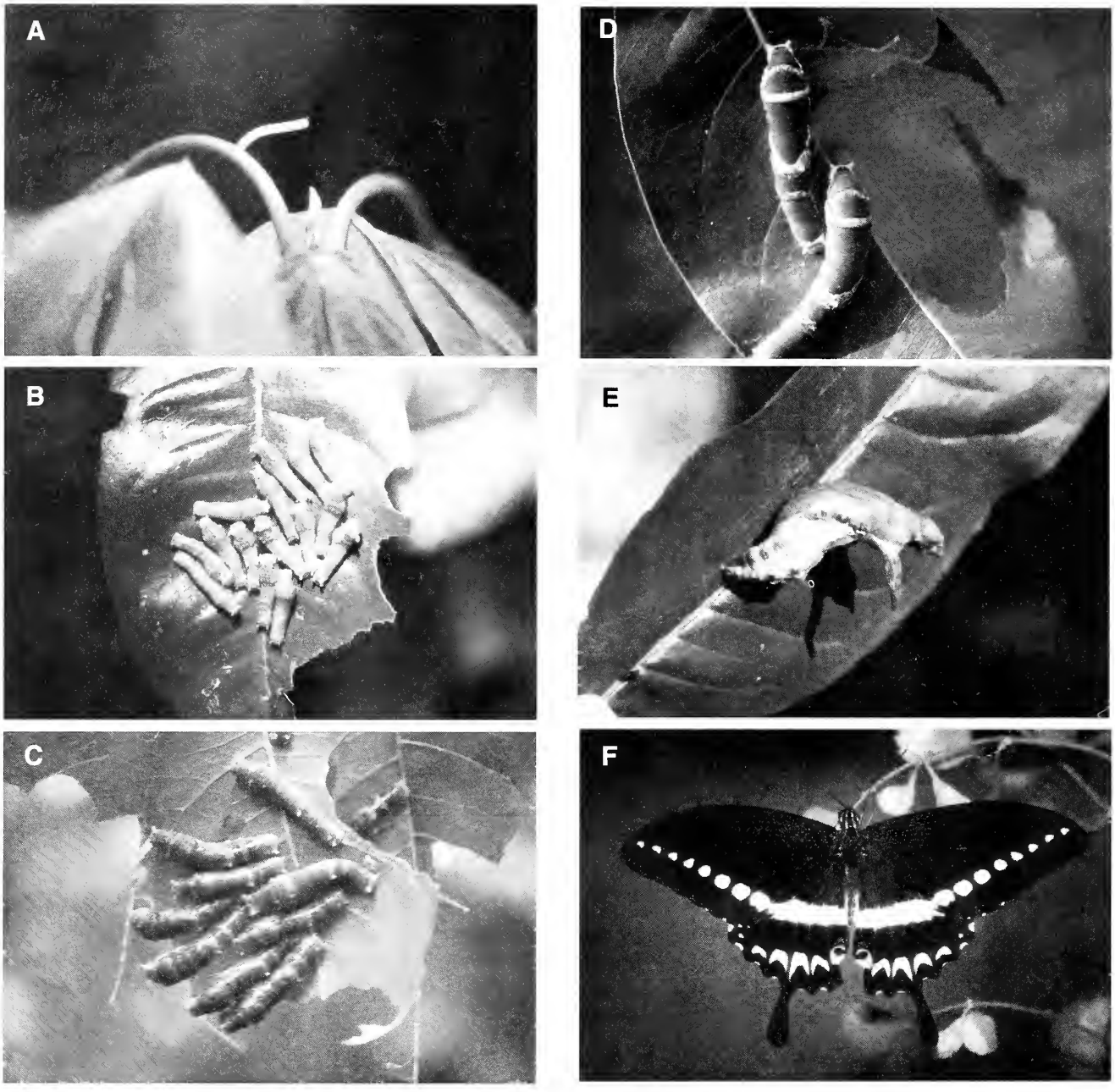

Fig. 1: Malabar Banded Swallowtail *Papilio liomedon*, A. Egg chain on *Evodia roxburghiana;* B. Larval congregation-Instar II; C. Larval congregation-Instar IV; D. Green and Blue colouration of IVth Instar Larvae; E. Pupa in Green colour; F. Female Butterfly (dorsal)

moved sideways, and were able to produce a faint knocking sound by wriggling movements of body.

2nd Instar

The larvae began to shed their old skin. The outer black covering of the head was also shed. The head was now pale orange, and the larvae 9 mm long. On the seventh day, the larvae became dark orange. After voracious feeding they congregated at the middle of the upper leaf surface (Fig. 1B). Four pairs of prominent spines were seen on segment 2, 7, 12 and 13. On the eighth day, the larvae were 14 mm long.

3rd Instar

The second moulting occurred on the ninth day. Larvae congregated over the leaf surface. They ate voraciously. When alarmed, the larva exserted its pale yellow osmeterium, giving a pungent smell.

On 11th day, the activities of the larvae became sluggish; they rested through most of the day on the underside of the leaves. A cream border was observed on the

Table 1: Life cycle of Malabar Banded Swallowtail *Papilio liomedon* Moore

Stages	No. of broods		No. of eggs	Hatching period/ Instar moulting/ Pupation in days	No. of Larva Emerged	No. of Larva Pupated	No. of Adults Emerged & the sex	Mortality of Insects due to Parasites/ Pathogens/ Predators	Survival Rate		Remarks
	Natural	Semi Natural							Natural Broods	Semi Natural broods	
	1	—	8	4 days	5	1	1-F	7	13%	—	3 eggs were not hatched 4 larvae emerged were eaten by snails
	2	—	5	4 days	0	0	0	5	0%	—	Eggs were eaten by snails
Egg	3	—	10	4 days	10	2	2-F	8	20%	—	8 larvae eaten by snail and praying mantis
	4	—	5	4 days	0	0	0	5	0%	—	Eggs were eaten by snails
	—	1	6	4 days	6	5	4 3-M 1-F	2	—	67%	Males outnumbered females
	—	2	14	4 days	14	7	7	7 3-M 4-F	—	50%	Females outnumbered males
	—	3	16	4 days	14	14	14 6-M 8-F	2	—	87%	Females outnumbered males
	—	4	9	4 days	8	8	8 3-M 5-F	1	—	89%	Females outnumbered males
Larva Ist Instar	—	—	—	5 days	—	—	—	—	—	—	—
IInd Instar	—	—	—	3 days	—	—	—	—	—	—	—
IIIrd Instar	—	—	—	4 days	—	—	—	—	—	—	—
IVth Instar	—	—	—	4 days	—	—	—	—	—	—	—
Vth Instar	—	—	—	3 days	—	—	—	—	—	—	—
VIth Instar	—	—	—	3 days	—	—	—	—	—	—	—
Pupa	—	—	—	15 days	—	—	—	—	—	—	Occured in two colours. Dead leaf colour and green colour
Adult	—	—	—	30-40 days (variable)	—	—	—	—	—	—	Male butterfly is more aggressive than the female butterfly

lower side of the body. The larvae were 22 mm long.

4th Instar

The third moulting occurred on the 13th day. The colour faded gradually till it became semi- translucent, pale orange blended with olive green (Fig. 1C, 1D). The cream border was more predominant on lower side of the body. The pair of spines on segment 12 disappeared. The tubercle on segment 7 was predominant. Most of the time the larvae rested on the leaves or branches of the food plant. The larvae were 30 mm long.

5th Instar

The fifth instar emerged on the 17th day. The colour of the larvae changed completely; it was now overall dark velvety green. The head was yellowish-orange with a red osmeterium. The body had golden yellow sides and golden crests on segments 4 and 5. It was swollen at segments 3 and 4, with lateral black eye spots. A black band was seen just behind the crest on segment 5. The 3 pairs of spines on segment 2, 7 and 13 were golden yellow. A yellow and reddish-brown blotched broad band was observed on segments 7 and 8. The bands on 7 and 8 together formed a 'V' on the dorsum of the larva. A reddish-brown blotched band was also observed on segments 9 and 10 (posterior segments). The larvae were now 38 mm long. They fed on old leaves and seemed to avoid tender leaves.

By the 19th day, they were 45 mm long. The larvae were a glistening velvet green, which appeared smoky blue when observed in direct sunlight. The larvae were less active and aggregated on the underside of leaves for their final moulting.

6th Instar

The fifth moulting occurred on the 20th day. The larvae were 50 mm long. After moulting, the larvae ate voraciously. They began to bite the leaves into small pieces and ate them. The small pieces of leaves were suspended on the thread produced by the larvae. They showed their brilliant red osmeterium when alerted. A pungent smell was also produced. They were also seen feeding at night. The larvae rested on self woven threads as on a bed at night. The larvae continued to feed till the 22nd day. They were 56 mm long before pupation.

Pupation

The lower portion of the pupal case was yellow or fluorescent green with purple lines. Between the head and thorax region, a projection similar to the handle of a jug was observed. This projection, which is about 6 mm long, is the distinguishing feature of the chrysalis of *Papilio liomedon* Moore. Just below the thoracic region, two yellow eye marks were apparent. Two black spots on the yellow rings resembled the eyes. Two black spots were also seen at the end of abdomen. The pupa was 30 mm long and 14 mm thick at the middle portion. The pupation period extended for 15 days (Fig. 1E).

Emergence of adult butterfly

On the morning of the 15th day of the pupal period, the pupal case became transparent. The creamy spots of the forewing were also visible. The butterflies emerged in the late morning and afternoon. The wingspan of the male butterfly was 90-100 mm. The male was dark brownish-black with a greenish, glistening creamy yellow band. On each hindwing near the tornal angle, there was a black spot partially encircled by a pale orange ring. Towards the base, a small spot of glistening violet was observed in each wing. The wingspan of the female was 100-110 mm. The female was dull brownish-black with a pale creamy yellow band. Bright orange colour at the tornal angle is the diagnostic feature of the female (Fig. 1F). The male butterfly was more aggressive than the female. In 20 minutes, the fluid had dried, the wings stretched to full span, and the butterfly actively fanned its wings, ready for flight.

Wynter Blyth (1957) has stated, "There seem to be two or three broods in the year, and in breeding the males largely outnumbered the females." But according to my observations, the females outnumber males in three out of four broods (Table 1). Talbot (1939) reported that the female lays ten eggs on tender leaves of *Acronychia laurifolia* Blume. On October 7, 1998, I observed a female laying 16 eggs on a tender shoot of *Evodia roxburghiana*, which has not been recorded earlier as a host plant of this butterfly.

In natural surroundings, the survival rate of *Papilio liomedon* Moore is less than 10% (Table 1). In simulated natural conditions in the lab, the survival rate is 70%. In natural surroundings snails were important predators, which ate most of the eggs laid by the female. Snails roam through the host plants in search of eggs and early instar larvae. During monsoon, the undergrowth of evergreen forests is heavily infested with snails. Other predators including spiders, praying mantis, black ants and parasitic wasps have also been observed. Degradation of evergreen forests through extensive human interference in recent years is another challenge to the existence of the species. The cutting and clearing of undergrowth, especially the food plants of this rare papilionid, causes depletion of its population in evergreen forests.

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REFERENCES

TALBOT, G. (1939): The Fauna of British India, including Ceylon and Burma, Butterflies Vol. 1, London, Taylor and Francis Ltd.

WYNTER BLYTH, M.A. (1957): Butterflies of the Indian Region, Bombay Natural History Society, Mumbai. Pp. 523.

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PITFALL TRAPS FOR ARTHROPODS: AN EVALUATION OF THEIR EFFICIENCY, WITH SPECIAL REFERENCE TO FIELD CRICKETS (GRYLLIDAE: ORTHOPTERA)[1]

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Pitfall trapping, a commonly used technique for sampling arthropods in the field, often involves the use of either poisonous or non-biodegradable chemicals. We explored the possibility of using a non-poisonous, degradable alternative, and edible oil in pitfall traps designed to sample arthropods. Our results showed that a film of edible oil over water is an effective substitute for detergent solution for the capture of insect groups such as crickets, grasshoppers, ants, cockroaches and flies. Only in the case of spiders was detergent found to be significantly more effective than oil. For crickets, we further showed that live trapping without the use of chemicals was a viable alternative to traps with chemicals. Pitfall trapping was, however, inadequate as a method to quantify relative abundance and habitat associations of crickets at the species level.

Key words: Orthoptera, Gryllidae, crickets, grasshoppers, pitfall traps, arthropods, insects, sampling

Pitfall trapping is a widely used technique for sampling surface arthropods such as ants, beetles, cockroaches, spiders and crickets (Southwood 1978). It is simple and inexpensive. A plastic or glass jar with steep sides is placed in a pit dug into the ground, so that the rim of the jar is level with the soil surface. In order to prevent trapped animals from escaping, such traps usually contain an aqueous solution of a chemical such as picric acid, iso-propanol, tri-sodium orthophosphate or a detergent. Traps designed to simultaneously kill and preserve arthropods may contain either formalin or ethylene glycol (Southwood 1978).

The efficiency of a pitfall trap increases with its circumference, and relatively large arthropods require larger traps to be efficiently captured (Luff 1975; Brennan *et al.* 1999). This in turn means increased volume of the chemical per trap. This poses a problem when sampling in remote forested areas or difficult terrain, since these chemical-filled traps must be transported out of the area after sampling: it would be undesirable to simply remove the trapped insects and empty the toxic contents of the trap into the soil. In the first experiment, we explored the possibility of using a non-poisonous, biodegradable substitute such as edible oil instead of detergents or poisonous chemicals in pitfall traps.

In the second experiment, we captured animals live in traps that contained no chemicals or solutions, but were designed to prevent the insects from escaping. Live trapping offers two major advantages over conventional pitfall trapping: the researcher may choose between different methods of killing or preservation. For example, insects collected for molecular studies need to be preserved in 90-95% ethanol, whereas those collected for morphological studies could be killed in cyanide jars and then preserved dry. Live trapping also permits behavioural or mark and recapture studies, and prevents the unnecessary killing of non-target groups including other invertebrates and small vertebrates that fall into the traps. These can be released into the habitat if the traps are frequently monitored.

We evaluated the efficiency of the above traps in capturing surface-dwelling field cricket and ground cricket species, and attempted to examine microhabitat associations and seasonal variations in the relative abundance of cricket species, using this technique.

METHODS

Experiment 1: To compare the trapping efficiency of pitfall traps containing plain water (W), water with a film of oil (O) and water with detergent (D), five sets (blocks) of three traps (each representing one treatment) were laid out in five different microhabitats (tall grass, short grass, mixed grass + forbs, forbs alone, and leaf litter). The experiment was designed to eliminate the possible effect of microhabitat in biasing capture rates and probabilities (Melbourne 1999). The three traps within a block were placed at a distance of 2 m from each other. Each trap consisted of a plastic bowl (21 cm diameter, 7 cm depth) sunk into the ground with the rim at surface level (Fig. 1a). The bowl was filled to about two-thirds of its volume with either plain water (as the control), or water with one ml of oil poured on the surface, or a 2% detergent solution. In this experiment, traps with plain water were used as controls, rather than empty traps, since the relatively small depth of the traps made it very easy for arthropods to crawl or fly out of empty traps. The traps were left open for 15 days and nights, over a period of three months from April-June 2000. All traps were

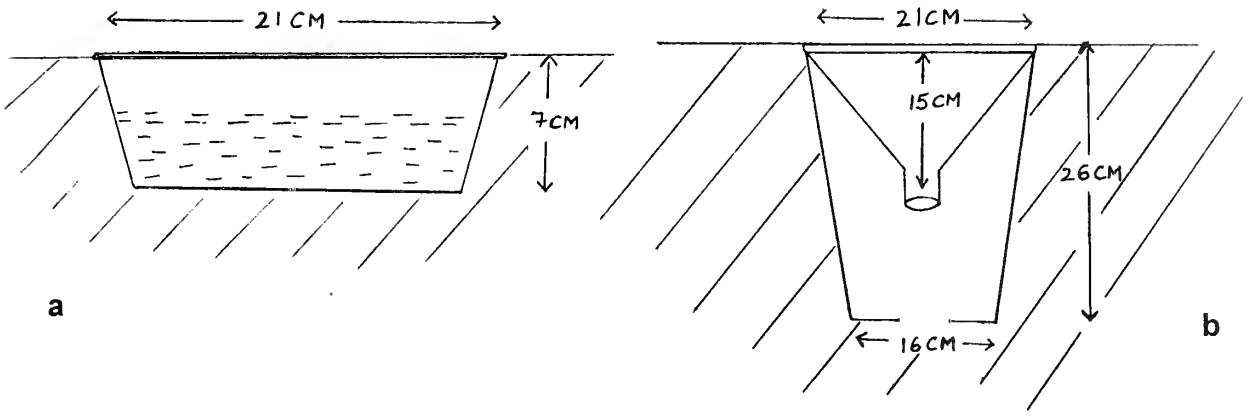

Fig. 1: Schematic illustration of the pitfall traps used in the study; a. Design of the traps used in the first experiment, b. Design of the trap type used in the second experiment

monitored at the end of a 24-hour period of sampling and the number of trapped individuals of different arthropod groups (both nymphs and adults) above one mm in length were counted and then air-dried for preservation.

Experiment 2: 'Live traps' were set up in different microhabitats: leaf litter, tall grass and short grass (less than six cm in height), with four traps per habitat, spaced 7 m apart. Each trap consisted of a deep, cylindrical plastic bucket (21 cm diameter, 26 cm depth) covered by a funnel that fit it exactly: this was sunk into the soil as in the previous experiment (Fig. 1b). A wet sponge and some soil were placed in each trap to keep it moist. During the monsoon, the bottom of the trap was removed to allow percolation of rainwater into the soil, and to prevent the trapped animals from drowning. Traps were monitored every second day for 15 weeks between January and September, during the dry season (January to April) for ten weeks and during the wet season (June to September) for five weeks. In this experiment, we focused only on crickets (Family Gryllidae, Order Orthoptera). The total number of crickets trapped every 48 hours was counted. Adults were identified to the genus or species level (wherever possible) using the taxonomic keys of Chopard (1969).

All experiments were carried out on the campus of the Indian Institute of Science, Bangalore, in non-landscaped areas with natural vegetation.

Data were first subjected to an analysis of variance, followed by *post-hoc* pair-wise comparisons using either *t*-tests (for the first experiment) or Tukey's HSD test (for the second experiment).

RESULTS

Are pitfall traps containing edible oil as effective as those containing detergents?

The mean number of individuals captured per trap (n = 5 traps for each of the three treatments) depended both on the treatment and the particular arthropod taxon being considered (ANOVA: $F = 15.47$, $P < 0.0001$ and $F = 21.9$, $P < 0.0001$ for the main effect of treatment and taxon respectively; $F = 5.52$, $P < 0.001$ for the interaction between them). Interestingly, for ants and cockroaches, traps containing water with a film of oil were far more effective than those containing either water alone or water with detergent (Fig. 2a: the letters a, b and c are used to indicate significant differences at $\alpha = 0.05$, *post-hoc* paired comparison *t*-tests).

For crickets and grasshoppers, traps containing water with oil or with detergent were significantly more effective than those containing water alone (Fig. 2b: symbols mean the same as in 2a. There were no significant differences in mean number captured between traps containing oil or detergent. Spiders, on the other hand, were significantly more likely to be captured in traps containing detergent solution, rather than those containing water with a film of oil, or water alone (Fig. 2b: paired comparison *t*-tests: $P < 0.05$ in each case). Dipterans (represented by flies) were captured in low numbers, but traps with oil or detergent added were significantly more effective than those containing only water (Fig. 2b: $P < 0.05$ in each case).

The mean rates of capture of crickets (defined as the number of individuals captured per trap per day) were 0.09 ±0.06 (water alone), 0.59 ±0.27 (water + oil) and 0.32 ±0.06 (water + detergent) respectively for the three treatments.

The effects of microhabitat, season and developmental status on mean capture rates of crickets using live trapping

The mean rate of capture of live crickets in empty traps in the second experiment was 0.36 ±0.13 individuals per trap per day. Since the capture rate in pitfall traps was low for crickets, we pooled the number of individuals captured per week in the four replicate traps (in each microhabitat) to use as the individual data points for statistical analysis. Analysis

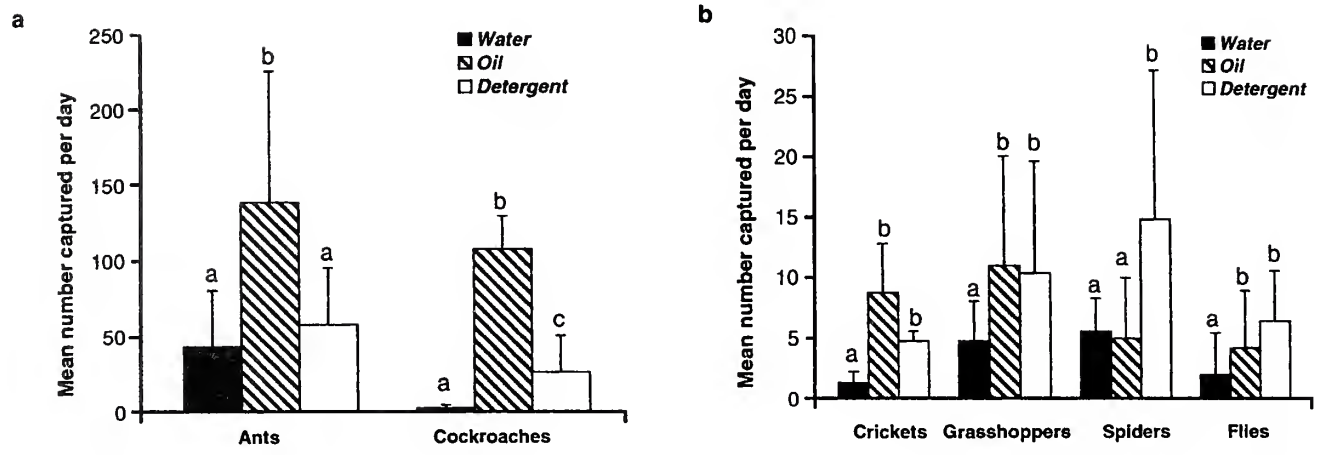

Fig. 2: Comparison of the effectiveness of pitfall traps containing only water, water with a film of oil, and detergent solution in capturing different arthropod taxa. The letters a, b and c above the bars indicate significant differences between treatments ($\alpha = 0.05$) (Note the difference in scale between the two graphs)

of variance was then carried out on these data to test the effects of three factors: microhabitat (leaf litter, tall grass or short grass), season (dry or wet) and developmental stage (nymph or adult) on mean capture rate of crickets. Both developmental status and season had highly significant independent effects ($F = 35.45$, $P < 0.0001$, $F = 22.65$, $P < 0.0001$ respectively), and microhabitat had a marginally significant independent effect, on capture rate ($F = 3.07$, $P = 0.05$). In addition, there were highly significant interactions between the effects of microhabitat and developmental status ($F = 13.17$, $P < 0.0001$), and between microhabitat and season ($F = 8.63$, $P < 0.001$). Significantly more nymphs than adults were captured (when pooled over the seasons) in both leaf litter and tall grass microhabitats, whereas nymphs and adults were trapped in approximately equal (low) numbers in the short grass habitat (Fig. 3a: the letters a and b are used to denote significant differences at the 0.05 level of significance using Tukey's HSD test). In the tall grass and short grass habitats, the mean number of crickets captured per week (pooling nymph and adult numbers) was far higher in the wet season than the dry (Fig. 3b). In the leaf litter habitat, however, the mean numbers captured were approximately the same in both wet and dry season.

Species composition

A total of 15 species of crickets were captured in live traps: 13 species belonging to six genera of the subfamily Gryllinae (field crickets) and two species of the genus *Pteronemobius* (subfamily Nemobiinae or ground crickets) (Table 1). Of the 15 species, ten were found as adults

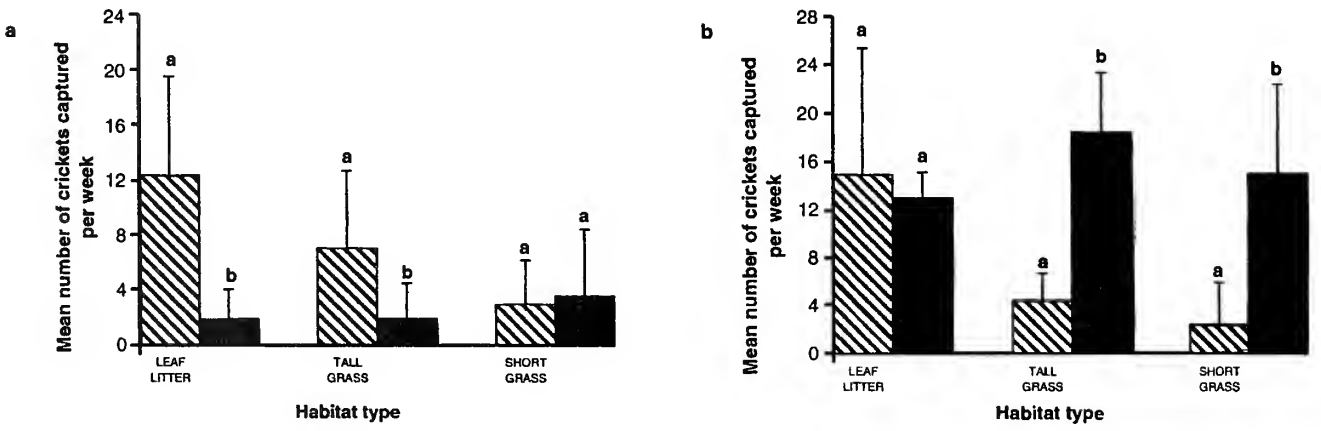

Fig. 3: Capture rates of crickets by live trapping; a: Comparison of capture rates of nymphal instars (hatched bars) and adults (black bars) in three types of micro-habitat. b: Comparison of capture rates of crickets between the dry (hatched bars) and wet (black bars) seasons in three types of micro-habitat. The letters a and b above the bars indicate significant differences between factors ($\alpha = 0.05$)

Table 1: Species composition and abundance of adult crickets captured in three micro-habitats in the dry and wet seasons

			Total number of individuals captured					
			Short grass		Tall grass		Leaf litter	
No.	Genus	Species	Dry	Wet	Dry	Wet	Dry	Wet
1	*Scapsipedus*	*grylloides*		15	1	4	17	8
2	*Loxoblemmus*	*equestris*		1		2		1
3	*Coiblemmus*	*compactus*		7		3		1
4	*Coiblemmus*	unknown				2		
5	*Itaropsis*	*tenellas*			1	1	3	
6	*Gryllopsis*	*maculithorax*		1		2		
7	*Gryllopsis*	*falconneti*		2				
8	*Gryllopsis*	*femorata*		3		2		
9	*Gryllopsis*	*furcata*				1		
10	*Gryllopsis*	unknown				1		
11	*Gryllus*	*fletcheri*				1		
12	*Gryllus*	*guttiventris*	7	6		3		
13	*Gryllus*	*confirmatus*		2				
14	*Pteronemobius*	*csikii*	7				1	
15	*Pteronemobius*	*taprobanensis*		1	3	2		
Total			14	38	5	24	21	10

exclusively in the wet season, one (*Pteronemobius csikii*) only in the dry season, with the other four species being found as adults in both wet and dry seasons. With respect to microhabitat, four species were unique to the tall grass and two to the short grass. Three species, namely *Scapsipedus grylloides*, *Coiblemmus compactus* and *Loxoblemmus equestris* were found in all three microhabitats. Of the remaining six species, five were found in both short and tall grass, whereas one species (*Pteronemobius csikii*) was shared between the leaf litter and short grass habitats.

The low capture rates of crickets precluded a meaningful statistical analysis of relative abundance and microhabitat preferences of species.

DISCUSSION

Our experiments show that the use of poisonous chemicals can be avoided in pitfall trapping of arthropods. A small quantity of edible oil is a good substitute for the more commonly used detergents, and does not compromise the efficiency of capture for insect groups such as crickets, grasshoppers, ants, cockroaches and flies. In fact, the capture rate for cockroaches and ants was much higher in traps containing oil rather than detergents, perhaps because the oil acted as an attractant to these highly chemosensitive animals. The use of both oil and detergent, however, makes mounting and preservation of specimens more difficult.

The efficiency of pitfall trapping has been studied earlier, for the effects on capture rates and probabilities, of features such as the material used, trap size, different chemicals and preservatives, and the frequency of sampling (Luff 1975; Vennila and Rajagopal 1999, 2000). Almost all of these studies have focused on one taxonomic group, the beetles. These studies have revealed that traps made of glass have significantly higher capture efficiencies than either plastic or metal (Luff 1975; Vennila and Rajagopal 2000). In their study of tropical carabid beetles, Vennila and Rajagopal (2000) found no significant differences in capture rates between traps containing different kinds of chemicals or preservatives. In their experiments, empty traps were significantly less effective than those containing chemicals. This may have been because their empty traps were not designed to prevent live insects from escaping.

For one group of insects, the crickets (Suborder Ensifera, Order Orthoptera), we have demonstrated the possibility of live trapping without compromising on capture rates. The mean rate of capture of live crickets in empty traps in the second experiment in our study was comparable with those yielded in the traps containing preservatives in the first experiment. Since the design of the traps was somewhat different in the two experiments, however (greater trap depth and the use of a funnel in the second experiment), it is possible that the capture efficiency of traps containing oil or detergent has been underestimated. As discussed earlier, live trapping

offers a number of advantages over conventional pitfall trapping, provided that it is possible to monitor traps frequently. The latter is an important caveat, since pitfall traps are typically used in large-scale studies for long-term monitoring of species diversity and relative abundance of arthropod fauna in different regions or habitats, where it is often not possible to monitor traps frequently and the use of preservatives becomes necessary. In studies involving larger arthropods in a narrow taxonomic category, such as field crickets, however, live trapping may be a viable alternative.

The estimates of relative abundance of species may also be more reliable with live trapping: the addition of chemicals may introduce strong biases in the capture probabilities of different taxa that may be attracted or repelled by these chemicals to different extents (Luff 1975). In our study, for example, ants and cockroaches were probably attracted by the scent of the oil, whereas spiders appeared to be attracted to detergent solutions.

In an extensive study that evaluated a number of sampling methods for insects in tropical forests, Gadagkar *et al.* (1990) found that whereas pitfall trapping was an effective method for hymenopterans, coleopterans, dipterans and hemipterans, capture rates for orthopterans were comparatively low. Our data also corroborate these results: the capture efficiency for ants and cockroaches was, on an average, higher than that for orthopterans, perhaps because orthopterans are generally less numerous than hymenopterans and dipterans. Inexplicably, few dipterans and coleopterans were captured in our study.

In the case of field and ground crickets, nymphal instars were trapped in significantly higher numbers than adults, in the leaf litter and tall grass microhabitats. This may be due to the higher density and smaller size of nymphs compared to adults, which would increase their probability of capture. In the short grass habitat, however, both nymphs and adults were captured at similar low rates, which may indicate that this is not a preferred habitat for either. Our empirical observations suggested, however, that the short grass was in fact a preferred habitat for the adults of at least four species of field crickets, two of which were never captured in the pitfall traps over the entire sampling period of 15 weeks.

In the grassy microhabitats, the mean abundance of field and ground crickets was much higher in the wet season than in the dry, reflecting a general increase in the abundance of both nymphs and adults, of a number of insect species during the monsoon. There were, however, no significant differences in mean abundance between the dry and wet seasons in the leaf litter microhabitat. This could be because the species inhabiting the grassy microhabitat are highly seasonal, with peak abundance during the monsoon, whereas those in the leaf litter habitat tend to occur throughout the year. The fact that 8 of the 15 species of crickets were trapped exclusively in grassy habitats during the wet season lends credence to this view.

The overall low capture rates of crickets in pitfall traps, however, precluded any meaningful quantitative analysis of relative abundance of species, both within and between microhabitats. The data shown in Table 1 were obtained after 15 weeks of sampling, and yet the numbers of crickets captured, particularly adults, were too low for statistical analysis of relative abundance at the species level. Other problems of pitfall trapping include the biases in trapping ability introduced by microhabitat structure, which could be different for different species (Melbourne 1997, 1999). This precludes the use of any general correction factor that could be applied to an entire taxon above the species level. As a result, the estimates of relative abundance of cricket species obtained from pitfall trap data are likely to be highly unreliable. In our experience, even species richness would be underestimated, since a number of cricket species that were found by *ad lib* acoustic and visual sampling did not appear in the pitfall traps. The efficiency of pitfall traps and the unreliability of the data obtained make it a poor method for a quantitative examination of ensiferan species richness and relative abundance. We believe that all-out acoustic and visual sampling may be more effective and reliable for the quantitative study of ensiferan species assemblages and our future efforts will be directed at examining and developing these techniques.

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REFERENCES

Brennan, K.E.C., J.D. Majer & N. Reygaert (1999): Determination of an optimal pitfall trap size for sampling spiders in a Western Australian Jarrah forest. *J. Insect Cons. 3(4)*: 297-307.

Chopard, L. (1969): The Fauna of India and adjacent countries. Orthoptera. Vol. 2. Grylloidea. Baptist Mission Press, Calcutta.

Gadagkar, R., K. Chandrashekhara & Padmini Nair (1990): Insect species diversity in the tropics: sampling methods and a case study. *J. Bombay Nat. Hist. Soc. 87(3)*: 337-353.

Luff, M.L. (1975): Some features influencing the efficiency of pitfall traps. *Oecologia 19*: 345-357.

Melbourne, B.A., P.J. Gullan & Y.N. Su (1997): Interpreting data

from pitfall-trap surveys: crickets and slugs in exotic and native grasslands of the Australian Capital Territory. *Mem. Mus. Vict. 56*: 361-367.

MELBOURNE, B.A. (1999): Bias in the effect of habitat structure on pitfall traps: an experimental evaluation. *Aust. J. Ecol. 24*: 228-239.

SOUTHWOOD, T.R.E. (1978): Ecological Methods with particular reference to the study of insect populations. Chapman & Hall, London and New York.

VENNILA, S. & D. RAJAGOPAL (1999): Optimum sampling effort for study of tropical ground beetles (Carabidae: Coleoptera) using pitfall traps. *Curr. Sci. 77(2)*: 281-283.

VENNILA, S. & D. RAJAGOPAL (2000): Pitfall trap sampling of tropical carabids (Carabidae: Coleoptera) – evaluation of traps, preservatives and sampling frequency. *J. Bombay Nat. Hist. Soc. 97(2)*: 241-246.

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ECOLOGY OF SNAKES IN AN URBAN ENVIRONMENT: AN ANALYSIS OF THE DATA ON SNAKES COLLECTED BY SUNDARVAN NATURE DISCOVERY CENTRE, AHMEDABAD[1]

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The Sundarvan Nature Discovery Centre in Ahmedabad (Gujarat), collected data on the frequency of occurrence of snakes and other reptiles during the period June 1996 to July 1998. Twelve species of snakes were encountered/released, Cobra (*Naja naja*) being the most frequently encountered species, closely followed by Checkered Keelback (*Xenochrophis piscator*) and Rat Snake (*Ptyas mucosa*). Studies on the seasonal abundance of snakes suggested that their peak occurrences, corresponding to the monsoon rains, are due to additions to the populations. Predictably, there is some evidence that snake abundance is positively correlated with ambient temperatures during the non-breeding season. An analysis of the habitat preferences of various snake species suggests that the occurrence of a species inside or outside residential premises is roughly correlated with its food preferences.

Key words: Snakes, Gujarat, wildlife rescue, Sundarvan, urban ecology

INTRODUCTION

Sundarvan Nature Discovery Centre (henceforth referred to as Sundarvan), a facility of the Centre for Environment Education (CEE)-Ahmedabad, has been active in nature education using live snakes as a medium, since its inception in 1978. The staff also helps local people to cope with snakes that may appear in residential premises or cause panic among the public (Urfi 1999a). This activity complements the wildlife rescue programmes undertaken by governmental agencies and has received wide appreciation and support from the public. In recent years, Sundarvan has also taken a number of initiatives in herpetological research (Urfi *et al.* 1999) such as breeding and release of endangered species of snakes (Urfi 1999b).

Although Gujarat is rich in herpetofauna, which is well documented (Gayen 1999; Vyas 1998), there are still lacunae in our knowledge on snake populations and patterns of their seasonal abundance. It is well known that reptiles are difficult to census (Daniel 1983). Therefore data on their abundance and distribution obtained through rescue programmes, such as Sundarvan's, can be invaluable for studying ecological patterns of reptilian populations.

As the coordinator of Sundarvan, I made an attempt to systematically record biological information about snakes handled during the period 1996-98. A preliminary analysis of the data (for 1996) with a view to discussing the conservation aspects of Sundarvan's snake programme has been reported earlier (Urfi 1999a). In this paper, a larger data set is used to evaluate the ecological aspects of snake abundance and distribution in Ahmedabad.

METHODS

To collect data about snakes in Ahmedabad, a 'snake form' was put into use by the author in June 1996. The information was collected in two categories:

A. People's perceptions about snakes, and information to evaluate the educational programmes of Sundarvan involving snakes. The results of this exercise have been reported in Urfi (1999a).

B. Data of ecological interest and snake biology, including 1. date, 2. location of the reptile when caught, 3. species, 4. size/length, 5. health condition and 6. colour.

All requests for removal of snakes/ reptiles were documented, irrespective of whether they were followed up or not. The usual procedure was that on receiving a call to deal with a snake, the park supervisor informed two of the specially trained ground level staff to attend to it. Once collected, the snake was either trans-located immediately to an area far from human habitation or temporarily kept in Sundarvan before relocation. On location, the Sundarvan staff was also required to distribute an educational booklet on snakes prepared by CEE (in English and the local language). The booklet contains information about snakes, common myths associated with them, their economic importance, what to do in case of a snake bite, etc.

Standard methods, such as the hooked aluminium stick, were used to handle snakes, which were immediately put into a cloth bag on being caught (Whitaker 1970). In most cases, the snakes could be identified accurately up to the species in the field by the Sundarvan attendants, but in case of doubt, they were brought for examination to the Park Supervisor and the Sundarvan Coordinator. To estimate length, the snake

was held by its tail and suspended against a graduated scale, fixed on a wall or temporarily fixed on a vertical object in the field, and the length was read to the nearest centimetre. However, since this procedure often had to be performed rapidly, the estimation of lengths was not always accurate. Moreover, the lengths of only a few species such as Cobra (*Naja naja*), Rat Snake (*Ptyas mucosa*) and Checkered Keelback (*Xenochrophis piscator*) could be ascertained in this way.

The data collected from June 1, 1996 to July 31, 1998 was later transcribed into a Minitab worksheet (Version 10) for statistical analysis. Meteorological data of the city of Ahmedabad for the corresponding period was purchased from the Indian Meteorological Department, Ahmedabad. The data was analyzed with a view to answering the following questions.

1. Which species are reported from Ahmedabad and with what frequency?
2. What are the temporal patterns of snake abundance and what biotic and abiotic factors influence these patterns?
3. What kinds of habitat within urban areas are frequented by different species of snakes?

RESULTS

Snakes handled by Sundarvan

During the study period, a total of 2,311 calls for help with problem snakes (and other reptiles) were received by Sundarvan, of which 1,142 resulted in reptiles being handled. The reptiles handled included 12 species of snakes and one species of lizard (the Common Indian Monitor, *Varanus bengalensis*). Besides these, some other species were also brought to Sundarvan or sometimes handled by Sundarvan staff. These species included the Indian Star Tortoise (*Geochelone elegans*) and Indian Mud Turtle (*Lissemys punctata*), but such cases were few (< 10 of the entire sample) and sporadic. Whereas 'snake calls' came from virtually all parts of Ahmedabad and also from areas lying outside the city limits, the majority (approximately 90%) were from a radius of about 8 km around Sundarvan (Fig. 1).

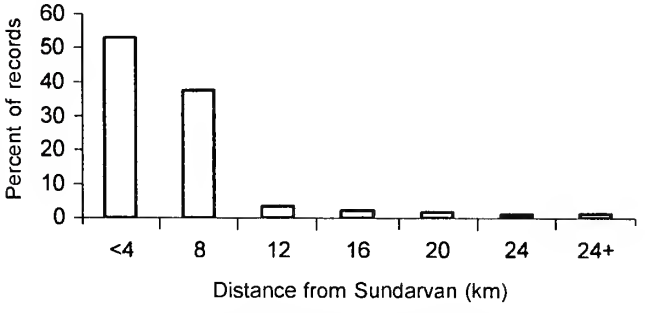

Fig. 1: Number of calls (% age) to deal with reptiles received by Sundarvan during 1996-98 in relation to the distance

Before we can start examining the Sundarvan data for any pattern, it is necessary to ascertain that it is free from bias brought about by human factors. For instance, the staff who went out on reptile handling missions could be reporting more or less calls than there actually were, and this could introduce some bias in the data. However, a bias if any would reflect itself in a number of ways, for instance as discrepancies in the number of snakes handled on different days of the week or as a discrepancy in the number of blank calls (i.e., no snake handled) and realized calls (i.e., those which resulted in a snake being handled). The number of calls on any given day was not influenced by the day of the week (Fig. 2). A goodness of fit test for the percentage of snakes being different from a uniform percentage of snakes being handled on each day of the week, yielded a non-significant result ($\chi^2 = 3.598$, d.f. = 6, NS). In addition, there was a high correlation between blank calls and realized calls (Fig. 3, $r^2 = 91.4\%$, d.f. = 23, $p < 0.001$). Further, if there were indeed any discrepancies in attending to calls then it would also be reflected as a poor correlation in the number of calls per month across the two seasons. We analyzed our data for any differences for the two years separately and discovered that the correlation (r^2) between calls attended per month for the seasons 1996-97 and 1997-98 was 84.3 % ($p = 0.001$).

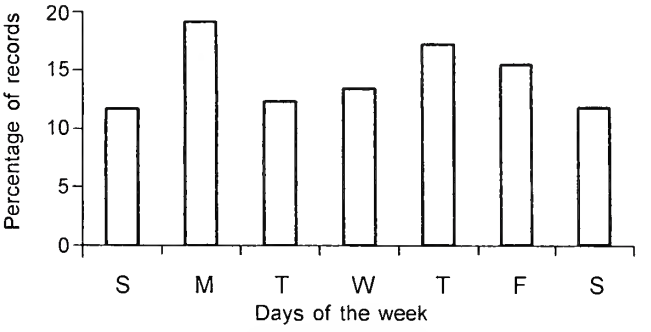

Fig. 2: Number of records for snakes handled by Sundarvan on each day of the week expressed as a percentage (Data for only a few randomly chosen months has been used)

In Ahmedabad, snake charmers are a regular, though not common, feature of the cultural landscape. Sometimes they let loose their snakes in housing localities and then on request from panic stricken people, catch them, extracting a small fee in the process (Whitaker and Whitaker 1986). The snakes used by snake charmers are easily recognized by their poor body condition and in the case of venomous snakes such as Cobra, by their fangs having been pulled out. In our sample, we came across some instances where the snake

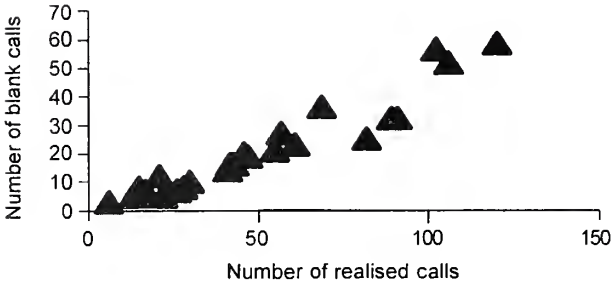

Fig. 3: Relationship between the number of realised calls and blank calls (per month) received by Sundarvan during the study period

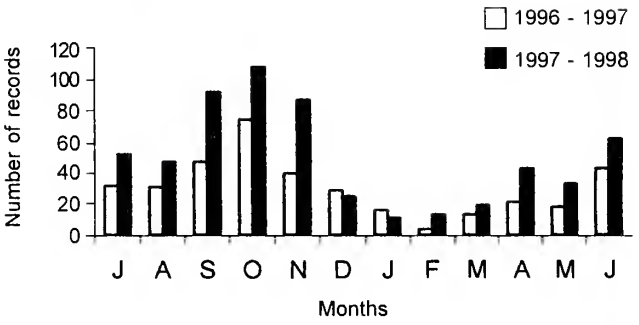

Fig. 4: Monthly distributions of the number of snakes for 1996-97 and 1997-98 recorded by Sundarvan

recovered was suspected to be one let loose by snake charmers, but such cases were few (<5).

From the data on the abundance of snakes during the study period (Table 1), it emerges that the Cobra is most abundant (35%), followed by Checkered Keelback (24%) and Rat Snake (20%). Incidentally, Cobras have also been reported from other cities in Gujarat (Snehal Patel, *pers. comm.*) as the most common species in snake rescue data.

Temporal patterns in snake abundance

Fig. 4 shows the seasonal abundance of snakes and reptiles for each of the two years of study. The monthly distribution for snakes differed significantly from that expected under the null hypothesis of equal numbers per month (GOF test $\chi^2 = 126.81$, 11 d.f., $P < 0.01$ for the season 1996-97 and $\chi^2 = 232.50$, 11 d.f., $P < 0.01$ for the season 1997-98.).The majority of the snakes handled by Sundarvan (approximately 75%) were from June to November during each of the two seasons. These results indicate a highly clumped distribution of snakes in the yearly cycle. As these months of reptilian abundance correspond to the monsoon, which stretches from June to September in western India, these seasonal peaks could be a result of the physical effects of the rains. It is possible that rain drives the reptiles out of their burrows, which get filled with water. While this idea is difficult to test, an alternative and perhaps more likely explanation could be that these seasonal peaks reflect recruitments to the population.

To test this idea, we segregated the data into two categories, young and adult, based on size. Since we had information on snake lengths for only a few species, this analysis could be done only for the Rat Snake, Cobra and

Table 1: Snakes rescued by Sundarvan during the period June 1996 to July 1998

Species	1996	1997	1998	Total
Typhlopidae				
Common Worm Snake *Ramphotyphlops braminus* (Daudin 1803)	1	0	0	1
Boidae				
Common Sand Boa *Eryx conicus* (Schneider 1801)	9	9	13	30
Red Sand Boa *Eryx johnii* (Russell 1801)	3	4	0	7
Colubridae				
Trinket Snake *Elaphe helena* (Daudin 1803)	1	0	0	1
Common Rat Snake *Ptyas mucosus* (Linnaeus 1758)	39	105	50	194
Banded Kukri *Oligodon arnensis* (Shaw 1802)	3	3	3	9
Common Wolf Snake *Lycodon aulicus* (Linnaeus 1758)	0	10	7	17
Striped Keelback *Amphiesma stolatum* (Linnaeus 1758)	2	17	4	23
Checkered Keelback *Xenochrophis piscator* (Schneider 1799)	69	129	31	229
Elapidae				
Common Krait *Bungarus caeruleus* (Schneider 1801)	30	56	18	104
Indian Cobra *Naja naja* (Linnaeus 1758)	96	190	55	341
Viperidae				
Saw-scaled Viper *Echis carinatus* (Schneider 1801)	1	3	0	4

Checkered Keelback for which individuals smaller than 60 cm, 45 cm and 45 cm, respectively were classified as juvenile (Daniel 1983; Whitaker 1978). When the combined data for the monthly abundance of the three species of snakes was plotted against the number of juveniles, a correlation was observed ($r^2 = 67.8\%$ $P < 0.001$), suggesting that the peaks of seasonal abundance could be due to the recruitment effort (Fig. 5).

To test the idea that weather conditions influence the number of calls received by Sundarvan, we explored the influence of temperature and rainfall using a subset of our data including only the winter months from November to February. Data for only four species, the Rat Snake, Checkered Keelback, Common Krait and Indian Cobra was used, as only these were recorded in large numbers (exceeding 100). As the results show (Fig. 6), the number of snakes handled was positively correlated with maximum temperature ($r^2 = 8.1\%$, d.f. = 238, $p < 0.001$) and minimum temperature ($r^2 = 15.5\%$, d.f = 238, $p < 0.001$). However, with respect to rainfall, no clear pattern emerged, due to the small sample size.

Habitat associations of snakes

As Table 2 shows, snakes are ubiquitous, to be found in every conceivable place, and indeed sometimes in quite unusual places too. We did not attempt to analyze habitat selection for each species individually because more information, especially on environmental factors at the local level, would be required for each of the habitats where snakes were found. However, from the available data it is still possible to study the extent to which each species had a propensity to be indoors or outdoors. From our analysis (Table 3), it appears that some snakes such as Common Wolf Snake (*Lycodon aulicus*) and Indian Cobra were mostly recorded indoors, while

Table 2: Habitats in Ahmedabad city from where snakes were rescued by Sundarvan during the study area

Indoors	Outdoors
Including residential houses, *godown*, water pump room in farm houses etc.	Heaps, Garbage Rubble/stone/bricks Woodpile
Bathroom Near water tap Near commode	*Others* Kitchen garden/nursery Trees in garden/orchard/farm Water tank, Parking lot Roads (in urban areas and on the periphery of the city, close to the country) Well
Kitchen Near gas cylinder	
Bedroom Beneath the bed	
Others Inside false ceiling Inside air-conditioner Inside fuse box Near window On door grills In cracks on the wall and on roofs tiles	

Rare and unusual sites: Motorcycle seat, Motor car engine, Swimming pool

Table 3: The frequency (%) with which different species of snakes were encountered in indoor or outdoor locations by Sundarvan along with information on their diets and foraging methods

Species	Indoor	Outdoor	Known diet & foraging method*
Common Sand Boa	14	86	Predominantly rats, occasionally frogs. Hatchlings feed on insects, mice, small lizards and later on birds and rodents. Prey caught by constriction
Red Sand Boa	16	84	Mainly rats (rodents). Prey caught by constriction.
Trinket Snake	50	50	Mainly rodents, occasionally birds and their eggs. Young consume insects and small lizards. Prey apparently caught by constriction.
Rat Snake	38	62	Very eclectic diet, includes rats, frogs, toads and also birds, geckos, bats and snakes. Capture of prey by stealth and power.
Banded Kukri	50	50	Geckos, skinks, small mice, bird & reptile eggs. Young feed on insects, their larvae and spiders. Prey caught by swift movements in which the strong teeth are useful.
Wolf Snake	84	16	Geckos, skinks, mice and frogs. Prey caught by swift movements in which the strong teeth are useful.
Striped Keelback	46	54	Mainly frogs but also toads, small lizards and rodents. Young known to feed on insects, tadpoles etc. Prey capture by stealth and swift strikes.
Checkered Keelback	36	64	Mainly fish, frogs and aquatic creatures. Prey captured by swift strikes.
Common Krait	47	53	Mainly snakes, lizards and rodents. Prey immobilized by poison.
Indian Cobra	57	43	Mainly rats. Prey immobilized by poison.

*from Daniel (1983) and Whitaker (1978)

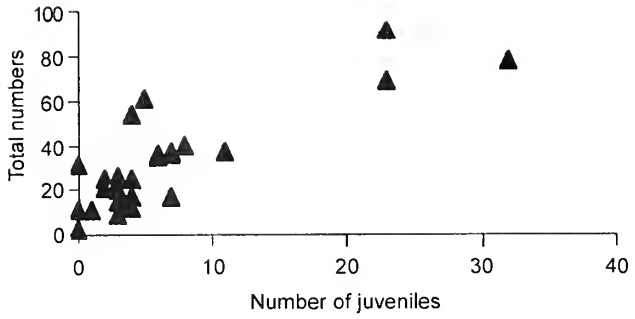

Fig. 5: The relationship between the number of juvenile snakes per month and the number of snakes of all age groups in that month, recorded by Sundarvan during the study period (Note this analysis includes data for only three species, Cobra, Checkered Keelback and Rat Snake)

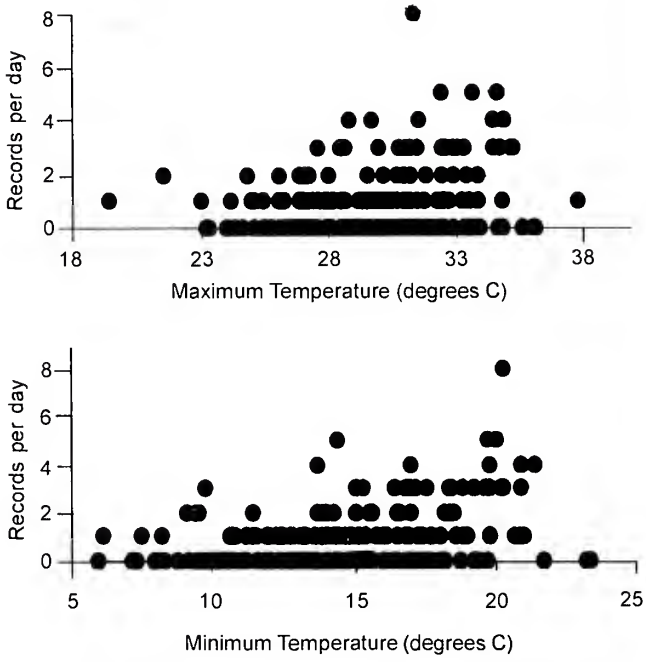

Fig. 6: The number of snakes handled by Sundarvan per day in winter (from November to February, data for the two seasons 1996-97 and 1997-98 combined) compared with daily maximum air temperature (upper graph) and daily minimum air temperature (lower graph) for the city of Ahmedabad. Each point represents a day

others such as Common Sand Boa (*Eryx conicus*), Red Sand Boa (*Eryx johnii*), Rat Snake, Striped Keelback (*Amphiesma stolatum*), Checkered Keelback and Common Krait (*Bungarus caeruleus*) were recorded outdoors on the majority of occasions (>50%). The rest of the species were recorded indoors and outdoors in equal proportions.

DISCUSSION

Excluding the Family Hydrophiidae (sea snakes), our sample has representatives of five out of the eight families of Serpentes recorded in Gujarat. The species missing in our sample could be those which are partial to undisturbed environment free of humans, in the less populated parts of the state, or those which are less cosmopolitan in distribution. Of course, the absence of some species in our sample could also mean that they were overlooked, but this is a remote possibility. Also, since our data emerges from reptiles as and when they are noticed by humans, it is not comparable to data from a census or inventory.

Our analysis of seasonal peaks of snake abundance strongly suggests that they are due to the higher proportion of juveniles in certain months. For cobra, egg laying is recorded in April and May, and can continue up to August according to Daniel (1983), with eggs hatching after a period of *c.* 60 days. Also, according to Whitaker (1978), the cobra may breed more than once per year. As for the Checkered Keelback, the egg laying period is reported to be November to May according to Daniel (1983) and March according to Whitaker (1978) with an incubation period of about 60-70 days. In the case of Rat Snake, egg laying is in August-September, the young being born during September and January.

The influence of environmental factors on the activity of reptiles is well known (Cloudsley-Thompson 1971). In this regard, our results indicating a positive relationship between ambient temperature and number of reptiles recorded are along predictable lines (Shine and Koenig 2001). However, the correlation is not strong, which could be due to the fact that individual species may have a different relationship with ambient environmental factors and this aspect needs to be probed further. One would also expect close relationships to emerge in the abundance patterns of snake numbers with rainfall. While rainfall would be negatively correlated with temperature, it will influence the behaviour of reptiles in novel ways (Auffenberg 1994).

It is reasonable to assume that the site where a snake is found would have something to do with its habitat preference, of which one of the crucial factors is food availability. Factors such as safety from predators, micro-climate (including temperature, humidity) could also play a role. While we have no information of the habitat characteristics with respect to micro-climate, it is possible to compare the known food preferences of various species and their occurrence outdoors or indoors, and the availability of food in these two broad categories. As the information on ten species of snakes (Table 3) suggests, among the outdoor type of snakes such as the two Boas and the Rat Snake, their food is also of the type which one would expect to find mostly outdoors. Contrary to

what its name suggests, the Rat Snake's diet is eclectic and does not consist entirely of rats (Daniel 1983). The Checkered Keelback's prey is mainly fish, frogs and other aquatic creatures that would be found in ponds and wetlands, and this is why it is reported mostly outdoors (64%). However, on 36% of the occasions it was encountered indoors, perhaps while it is in transit from one habitat patch, which is often isolated and fragmented, to another.

Among the snakes found indoors, the Wolf Snake is at the top of the list. Its main prey is recorded to be geckos and inside Indian homes the Asian House Gecko (*Hemidactylus flaviviridis*) is a common and abundant prey. In our study, the Cobra was also largely an indoor species, with 57% cases reported from indoors. This may be because its principal food is the rat, which is a common pest in all types of human premises. Studies have also shown a high correlation between the number of cobras and the build up of rat populations at the time of paddy crop harvesting in certain rural areas of India (Whitaker 1978). Generally speaking, wherever there are rats, cobras are likely to follow.

Snakes are usually seen and reported when they are on the move in search of food, or while prospecting new habitats as their original habitat gets destroyed due to land modification. Given that in our sample the majority of the reptiles were recovered from an area of 8 km around Sundarvan, it would be useful to examine the development in this area. The information on the population growth and built up area, as revealed by satellite imagery data and ground surveys indicates that the area around Sundarvan is undergoing massive modification, with numerous housing and commercial complexes coming up (Bhowmick *et al.* 1997). From the viewpoint of both conservationists and town planners, this merits serious discussion.

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REFERENCES

AUFFENBERG, W. (1994): The Bengal monitor. University Press of Florida, Gainesville.

BHOWMIK, M.M., N.M. BHAVASAR, K.J. GAJJAR, P.P. DESAI, B.S. AGGARWAL, S.K. PATHAN, R.J. BHANDERI, A.S. ARYA & R.R. NAVALGUND (1997): Development plan of Ahmedabad Urban Development Authority for the year 2011. Vol. 1. Remote sensing and GIS approach. Technical report. Ahmedabad Urban Development Authority, Ahmedabad and Space Applications Centre, Ahmedabad.

CLOUDSLEY-THOMPSON, J.L. (1971): The temperature and water relations of reptiles. Merrow, London.

DANIEL, J.C. (1983): The Book of Indian Reptiles. Bombay Natural History Society, Mumbai. Pp. 141.

GAYEN, N.C. (1999): A synopsis of the reptiles of Gujarat, western India. *Hamadryad 24*: 1-22.

SHINE, R. & J. KOENIG (2001): Snakes in the garden: an analysis of reptiles "rescued" by community-based wildlife carers. *Biological Conservation 102*: 271-283.

URFI, A.J. (1999a): The snake conservation programme of Sundarvan Nature Discovery Centre, Ahmedabad (Gujarat, India): An evaluation. *Zoos' Print. 14*: 7-10.

URFI, A.J. (1999b): Breeding and releasing Indian rock pythons, Ahmedabad, India. *Re-introduction news (IUCN)*. Pp. 17, 2 4.

URFI, A.J., K. JETHWA & E.K. NARESHWAR (1999): Some recent herpetological initiatives of Sundarvan Nature Discovery Centre, Ahmedabad. *Cobra*: *37*: 17-23.

VYAS, R. (1998): The reptiles of Gujarat state: updated distribution. *Tigerpaper 25*: 8-14.

WHITAKER, R. (1970): The catching of snakes. *J. Bombay Nat. Hist. Soc. 68*: 274-278.

WHITAKER, R. (1978): Common Indian snakes, a field guide. Macmillan, Delhi. 154 pp.

WHITAKER, Z. & R. WHITAKER (1986): The snakes around us. National Book Trust, Delhi. 61 pp.

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STATUS AND DIVERSITY OF FISH FAUNA IN DIBRU-SAIKHOWA NATIONAL PARK, ASSAM[1]

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Fish species from various aquatic bodies of Dibru-Saikhowa National Park were collected and identified during the study period 2000-2002. Altogether 76 species of fish from 24 families and 49 genera, including 7 endangered species were recorded from the study area. The status and abundance of all these recorded species are discussed, with the natural and anthropogenic pressures that they are facing.

Key words: Fish fauna, status, abundance, protected area, Dibru-Saikhowa National Park, endangered, anthropogenic pressures

INTRODUCTION

Northeast India comprises seven states namely Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura, each with vast and varied water resources in the form of rivers (19,150 km), reservoirs (23,792 ha), beels, lakes and swamps (1,43,740 ha), ponds and mini-barrages (40,808 ha), and low-lying paddy-cum-fish culture systems (2,780 ha) (Mahanta *et al.* 2001). The region is considered one of the hotspots of freshwater fish biodiversity of the world (Kottelat and Whitten 1996). There are two major drainage systems in this area – River Brahmaputra in the northern region, and River Barak in the southern region. Besides these two rivers, the Chindwin drainage system also feeds the eastern region. With its 267 fish species, northeast India contributes about 33.13% of the total freshwater fishes of India (Sen 2000). Among its seven states, Assam has the largest number of fishes with 200 species (Mahanta *et al.* 2001).

A number of workers have studied the fishes of Assam (Motwani *et al.* 1962; Yadava and Chandra 1994; Biswas 1998; Sarkar and Ponniah 2000; Biswas and Boruah 2000; Boruah and Biswas 2002; Bhattacharjya *et al.* 2001). However, few reports are available on the fishes of protected areas of Assam (Sen and Choudhury 1977; Biswas *et al.* 1996; Dutta *et al.* 1998; Wakid and Biswas 2001). Due to this paucity of information, and to begin the evaluation of the diversity and status of fish fauna in the protected areas of Assam, an attempt has been made to investigate the fish fauna of Dibru-Saikhowa National Park.

STUDY AREA

Dibru-Saikhowa is the easternmost National Park of Assam, with an area of 340 sq. km, extending from 27° 35' to 27° 45' N and 95° 10' to 95° 40' E in Tinsukia and Dibrugarh districts. This whole area, which is now becoming a river island, is flanked by River Brahmaputra on the northern side and River Lohit on the southern, eastern and western sides. However, the conversion of Dibru-Saikhowa National Park into a river island is of recent origin (since 2000). The geomorphological change has resulted from the widening of Dangori and Dibru rivers and shifting of the course of the Lohit river (Sarma and Phukan 2003).

The entire area is flat terrain comprising the flood plain of the Brahmaputra and Lohit rivers. It has a subtropical climate with an annual rainfall of 2,300-2,800 mm. The elevation averages 118 m above msl, with a variation of 110-126 m. There are large numbers of perennial streams (namely Paropara jan, Salbeel nallah, Dodhiajan, Laikajan, Ajuka, etc.) and seasonal streams (namely Garamjan, Erasuti, etc.). Perennial as well as seasonal wetlands and marshes (namely Tarali, Salbeel, Burhi beel, Hatighuli, Nagapather, etc.), also criss-cross the entire National Park (Wakid 2004).

MATERIAL AND METHODS

The present study was conducted in Dibru-Saikhowa National Park during June 2000 to June 2002, mainly in the pre-monsoon, post-monsoon and winter seasons. Topographical maps of the Survey of India (scale 1:50,000) were used to trace the water bodies of the area, and fish specimens were collected from the identified water bodies with the help of cast net, scoop net and gill net. Efforts were made to avoid statistical bias. Samples were preserved in 10% formalin and brought to the laboratory for identification and further studies. Identifications were made with the help of Jayaram (1981, 1999); Dutta Munshi and Shrivastava (1988) and Talwar and Jhingran (1991). Anon. (1998) was followed to determine their global status.

Table 1: Diversity, abundance and status of fish fauna in Dibru-Saikhowa National Park

Scientific Name	Abundance	IUCN status
Family: Notopteridae		
1. *Notopterus notopterus* (Pallas)	+	LRnt
2. *Chitala chitala* (Ham. - Buch.)	++	EN
Family: Anguillidae		
3. *Anguilla bengalensis bengalensis* (Gray & Hardwicke)	+	EN
Family: Clupeidae		
4. *Gudusia chapra* (Ham. - Buch.)	++	LRlc
5. *Hilsa* (*Tenualosa*) *ilisha* (Ham. - Buch.)	+	VU
Family: Cyprinidae		
6. *Amblypharyngodon mola* (Ham. - Buch.)	+++	LRlc
7. *Aspidoparia jaya* (Ham. - Buch.)	+++	VU
8. *A. morar* (Ham. - Buch.)	+++	LRnt
9. *Barilius barila* (Ham. - Buch.)	++	LRnt
10. *B. barna* (Ham. - Buch.)	+	LRnt
11. *B. bendelisis* (Ham. - Buch.)	+	LRnt
12. *Bengana* (formerly *Rasbora*) *elenga* (Ham. - Buch.)	++	NA
13. *Catla catla* (Ham. - Buch.)	+++	VU
14. *Chela cachius* (*atpar*) (Ham. - Buch.)	+++	NA
15. *C. laubuca* (Ham. - Buch.)	++	LRlc
16. *Cirrhinus mrigala* (Ham. - Buch.)	+++	LRnt
17. *C. reba* (Ham. - Buch.)	++	VU
18. *Crossocheilus latius latius* (Ham. - Buch.)	+++	DD
19. *Danio dangila* (Ham. - Buch.)	++	NA
20. *Esomus danricus* (Ham. - Buch.)	+++	LRlc
21. *Labeo angra* (Ham. - Buch.)	++	LRnt
22. *L. bata* (Ham. - Buch.)	+++	LRnt
23. *L. boga* (Ham. - Buch.)	++	LRnt
24. *L. calbasu* (Ham. - Buch.)	+++	LRnt
25. *L. gonius* (Ham. - Buch.)	+++	LRnt
26. *L. pangusia* (Ham. - Buch.)	++	LRnt
27. *L. rohita* (Ham. - Buch.)	++	LRnt
28. *Rasbora daniconius* (Ham. - Buch.)	+++	LRnt
29. *Puntius conchonius* (Ham. - Buch.)	+++	VU
30. *P. sarana sarana* (Ham. - Buch.)	++	VU
31. *P. sophore* (Ham. - Buch.)	+++	LRnt
32. *P. ticto* (Ham. - Buch.)	+++	LRnt
33. *Tor putitora* (Ham. - Buch.)	++	EN
Family: Balitoridae		
34. *Acanthocobitis* (= *Nemacheilus*) *botia* (Ham.- Buch.)	++	LRnt
Family: Cobitidae		
35. *Botia dario* (Ham.- Buch.)	+	NA
36. *B. rostrata* Gunther	+	NA
Family: Bagridae		
37. *Aorichthys aor* (Ham.- Buch.)	+++	NA
38. *Mystus bleekeri* (Day)	+++	VU
39. *M. cavasius* (Ham. - Buch.)	+++	LRnt
40. *M. tengara* (Ham.- Buch.)	+++	NA
41. *M. vittatus* (Bloch)	+++	VU
42. *Rita rita* (Ham. - Buch.)	+	LRnt
Family: Siluridae		
43. *Ompok bimaculatus* (Bloch)	++	EN
44. *O. pabda* (Ham. - Buch.)	++	EN
45. *O. pabo* (Ham. - Buch.)	++	NA
46. *Wallago attu* (Bloch & Schneider)	+++	LRnt

Table 1: Diversity, abundance and status of fish fauna in Dibru-Saikhowa National Park (*contd.*)

Scientific Name	Abundance	IUCN status
Family: Schilbeidae		
47. *Ailia coila* (Ham. - Buch.)	++	VU
48. *Clupisoma garua* (Ham. - Buch.)	++	VU
49. *Eutropiichthys vacha* (Ham. - Buch.)	++	EN
50. *Silonia silondia* (Ham. - Buch.)	++	LRnt
Family: Pangasiidae		
51. *Pangasius pangasius* (Ham. - Buch.)	+	CR
Family: Sisoridae		
52. *Bagarius bagarius* (Ham. - Buch.)	+++	VU
53. *Sisor rhabdophorus* Ham. - Buch.	+	EN
Family: Claridae		
54. *Clarias batrachus* (Linn.)	+++	VU
Family: Heteropneustidae		
55. *Heteropneustes fossilis* (Bloch)	+++	VU
Family: Chacidae		
56. *Chaca chaca* (Ham. - Buch.)	++	NA
Family: Belonidae		
57. *Xenentodon cancila* (Ham. - Buch.)	+++	LRnt
Family: Symbranchidae		
58. *Monopterus cuchia* (Ham. - Buch.)	++	LRnt
Family: Chandidae		
59. *Chanda nama* Ham. - Buch.	+++	NA
Family: Nandidae		
60. *Badis badis* (Ham. - Buch.)	+	NA
61. *Nandus nandus* (Ham. - Buch.)	+	LRnt
Family: Gobiidae		
62. *Glossogobius giuris* (Ham. - Buch.)	++	LRnt
Family: Anabantidae		
63. *Anabas testudineus* (Bloch)	+	VU
Family: Belontidae		
64. *Colisa fasciatus* (Schneider)	+++	LRnt
65. *C. lalia* (Ham. - Buch.)	++	NA
66. *C. sota* (Ham. - Buch.)	+++	NA
Family: Channidae		
67. *Channa barca* (Ham. - Buch.)	+++	NA
68. *C. stewarti* (Playfair)	++	NA
69. *C. marulius* (Ham. - Buch.)	+++	LRnt
70. *C. punctatus* (Bloch)	+++	LRnt
71. *C. striata* (Bloch)	+++	LRlc
72. *C. orientalis* (*gachua*) (Schneider)	++	VU
Family: Mastacembelidae		
73. *Mastacembelus armatus* (Lacepede)	+++	NA
74. *Macrognathus aral* (Bloch)	+++	LRnt
75. *M. pancalus* Ham. - Buch.	+++	LRnt
Family: Tetraodontidae		
76. *Tetraodon cutcutia* (Ham. - Buch.)	+++	LRnt

CR: Critically Endangered, EN: Endangered, LRnt: Low Risk near threatened, LRlc: Low Risk least concern, VU: Vulnerable, DD: Data Deficient, NA: Not Assessed, +: Rare, ++: Occasional, +++: Common

RESULTS AND DISCUSSION

From all the water bodies of Dibru-Saikhowa National Park, a total of 76 species of fish were collected and identified (Table 1). These species represent 24 families and 49 genera, of which Family Cyprinidae ranks highest with 28 species. Among the genera, the most abundant was *Labeo* with seven species. According to the status given by IUCN, the species

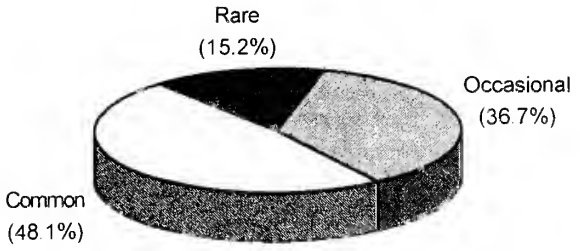

Fig. 1: Relative abundance of fish fauna in Dibru-Saikhowa National Park

we recorded include one critically endangered (CR), seven endangered (EN), thirty-one Lower Risk-near threatened (LRnt), five Lower Risk-least concern (LRlc), fifteen vulnerable (VU), one data deficient (DD), while sixteen species were not assessed (NA) (Table 2). The endangered and critically endangered species recorded are shown in Table 3. From the estimation of relative abundance, 13 species were categorized as rare, 27 as occasional and 36 species as common (Fig. 1).

The water bodies of the Park have been facing both natural and anthropogenic pressure. Among the natural pressures, the main one is the high rate of siltation caused by the frequent floods of River Brahmaputra and River Lohit. The impact of flooding caused by the Lohit at the Park is much greater than that of the Brahmaputra. Due to deforestation in its catchment areas, Lohit carries an enormous silt load during every flood, which gets deposited on the floor of the wetlands. This results in eutrophication in most of the wetlands of Dibru-Saikhowa National Park, notably Raidang beel. The shrinkage of habitat has a tremendous effect on the abundance of many species like *Botia dario, Nandus nandus, Anabas testudineus* from this National Park.

Among the anthropogenic pressures, fishing is the greatest threat to the Park. There are more than 36 fringe villages and two forest villages in this National Park and majority of the villagers are dependent on fishing in and around the waterbodies of the Park for their livelihood. This dependence is increasing day by day due to rapid population growth as well as loss of agricultural land due to erosion and siltation by frequent floods. This leads to illegal practices such as fishing with monofilament gill-nets and fish poisons, increased fishing intensity, and fishing in the core area of the Park, which are becoming major threats to the fish fauna of the Park.

Table 2: The status and diversity of the recorded fish species from the Dibru-Saikhowa National Park

Sl. No.	Family	Status of Family							Total
		CR	EN	LRnt	LRlc	VU	DD	NA	
1.	Notopteridae	—	1	1	—	—	—	—	2
2.	Anguillidae	—	1	—	—	—	—	—	1
3.	Clupeidae	—	—	—	1	1	—	—	2
4.	Cyprinidae	—	1	15	3	5	1	3	28
5.	Balitoridae	—	—	1	—	—	—	—	1
6.	Cobitidae	—	—	—	—	—	—	2	2
7.	Bagridae	—	—	2	—	2	—	2	6
8.	Siluridae	—	2	1	—	—	—	1	4
9.	Schilbeidae	—	1	1	—	2	—	—	4
10.	Pangasiidae	1	—	—	—	—	—	—	1
11.	Sisoridae	—	1	—	—	1	—	—	2
12.	Claridae	—	—	—	—	1	—	—	1
13.	Heteropneustidae	—	—	—	—	1	—	—	1
14.	Chacidae	—	—	—	—	—	—	1	1
15.	Belonidae	—	—	1	—	—	—	—	1
16.	Symbranchidae	—	—	1	—	—	—	—	1
17.	Chandidae	—	—	—	—	—	—	1	1
18.	Nandidae	—	—	1	—	—	—	1	2
19.	Gobiidae	—	—	1	—	—	—	—	1
20.	Anabantidae	—	—	—	—	1	—	—	1
21.	Belontidae	—	—	1	—	—	—	2	3
22.	Channidae	—	—	2	1	1	—	2	6
23.	Mastacembelidae	—	—	2	—	—	—	1	3
24.	Tetrodontidae	—	—	1	—	—	—	—	1
	Total	1	7	31	5	15	1	16	76

CR: Critically Endangered, EN: Endangered, LRnt: Low Risk near threatened, LRlc: Low Risk least concern, VU: Vulnerable, DD: Data Deficient, NA: Not Assessed

Table 3: List of Critically Endangered and Endangered fish species from Dibru-Saikhowa National Park

No.	Name of species	Abundance
1.	*Pangasius pangasius* (Ham-Buch.)	+
2.	*Chitala chitala* (Ham.)	++
3.	*Anguilla bengalensis* (Gray)	+
4.	*Tor putitora* (Ham-Buch.)	++
5.	*Ompok bimaculatus* (Bloch)	++
6.	*O. pabda* (Ham-Buch.)	++
7.	*Eutropichthys vacha* (Ham-Buch.)	++
8.	*Sisor rhabdophorous* (Ham-Buch.)	+

CONCLUSION

Besides the fish fauna, there are some other important species in the Dibru-Saikhowa National Park, which are totally piscivorous. Among them, the most prominent is the freshwater dolphin (*Platanista gangetica*). Wakid and Biswas (2002) have reported a residential population of *P. gangetica* from this National Park, probably the densest and only resident dolphin population in the entire Upper Brahmaputra basin. This dolphin population is under threat from extensive fishing, which affects the whole aquatic environment in the area. Therefore, conservation of fish fauna in this National Park is essential not only to sustain the fish diversity, but also the entire aquatic ecosystem. Proper implementation of the Indian Fisheries Act, and incentives for sustainable utilisation of the aquatic bodies (Biswas and Boruah 2000) will improve the present status of the fish fauna of Dibru-Saikhowa National Park.

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REFERENCES

ANON. (1998): Report of the workshop on Conservation Assessment and Management Plan (CAMP) for Freshwater Fishes of India. Zoo Outreach organization and NBFGR, Lucknow, 22-26 September, 1997, 156 pp.

BHATTACHARJYA, B.K., M. CHOUDHURY, V.V. SUGUNAN, B. ACHARJEE & U.C. GOSWAMI (2001): Ichthyofaunistic resources of Assam with a note on their sustainable utilization. Pp. 30-31. *In*: Integration of fish biodiversity conservation and development of fisheries in North-Eastern region through community participation. (Ed: Mahanta, P.C.). NBFGR Publications, Lucknow.

BISWAS, S.P. (1998): Ecology of chars or river islands of the Brahmaputra with special reference to the Fisheries. Final Technical report submitted to the Ministry of Environment and Forests, Govt. of India, New Delhi, 55 pp.

BISWAS, S.P., A. BARUAH, D. BARUAH & R.S.L. MOHAN (1996): Present status of aquatic fauna in the upper stretches of the Brahmaputra. *Bull. Life Sci. 6*: 25-32.

BISWAS, S.P. & S. BORUAH (2000): Ecology of river dolphin (*Platanista gangetica*) in the Upper Brahmaputra. *Hydrobiologia 430*: 97-111.

BORUAH, S. & S.P. BISWAS (2002): Ecohydrology and fisheries of the upper Brahmaputra basin. *The Environmentalist 22*: 119-131.

DUTTA, S., J.M. DUTTA & M. PHUKAN (1998): Chakrashila Wildlife Sanctuary: A documentation of its biodiversity. *Nature's Beckon*, 45 pp.

DUTTA MUNSHI, J.S. & M.P. SHRIVASTAVA (1988): Natural History of Fishes and Systematics of Freshwater Fishes of India. Narendra Publishing House, New Delhi. 382 pp.

JAYARAM, K.C. (1981): Freshwater fishes of India. A Handbook of the Zoological Survey of India, Calcutta. 475 pp.

JAYARAM, K.C. (1999): Freshwater fishes of the Indian region. Narendra Publishing House, Delhi, India. 551 pp.

KOTTELAT, M & T. WHITTEN (1996): Freshwater biodiversity in Asia with special reference to fish. *World Bank Tech. Paper No. 343*: 17-22. The World Bank, Washington, DC.

MAHANTA, P.C., L.K. TYAGI, D. KAPOOR & A.G. PONNIAH (2001): Integration of fish biodiversity conservation and development of fisheries in north-eastern region: Issues and approach. Pp. 1-8. *In*: Integration of fish biodiversity conservation and development of fisheries in North-Eastern region through community participation. (Ed: Mahanta, P.C.). NBFGR Publication, Lucknow.

MOTWANI, M.P., K.C. JAYARAM & K.L. SEHGAL (1962): Fish and fisheries of Brahmaputra river system, Assam 1. Fish fauna with observation on their zoogeographical significance. *Trop. Ecol. 3(1-2)*: 17-23.

SARKAR, U.K. & A.G. PONNIAH (2000): Evaluation of north-east Indian fishes for their potential as cultivable, sport and ornamental fishes along with their conservation and endemic status. Pp. 11-30. *In*: Fish biodiversity of north-east India (Eds: Ponniah, A.G. & U.K. Sarkar). NBFGR-NATP Publ. 2, 228 pp.

SARMA, J.N. & M. PHUKAN (2003): Erosion and change in the course of the river Brahmaputra around Dibrugarh and Tinsukia district of Assam, based on remote sensing data. Proc. ISPRS WG VII/3 workshop and ISRS Annual Convention, 9-12 Dec., 2003, Thirubhananthapuram (Abst.).

SEN, N. & S. CHOUDHURY (1977): On a collection of fish from Manas Wildlife Sanctuary (Kamrup-Assam) and adjacent areas. *Newsletter, ZSI 3(4)*: 199-204.

SEN, N. (2000): Occurrence, distribution and status of diversified fish fauna of north-east India. Pp. 31-48. *In*: Fish biodiversity of north-east India (Eds: Ponniah, A.G. & U.K. Sarkar). NBFGR. NATP Publ. 2, 228 pp.

TALWAR, P.K. & A.G.K. JHINGRAN (1991): Inland fishes of India and adjacent countries. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi. 1158 pp.

WAKID, M. (2004): Studies on certain aspects of ecology and behaviour of the river dolphin (*Platanista gangetica*) in Dibru-Saikhowa National Park, Assam. Unpublished Ph.D. Thesis, Dibrugarh University, Assam, 151 pp.

WAKID, A. & S.P. BISWAS (2001): Anthropogenic pressures on aquatic habitats: A case study in the Laika forest village of Dibru-

Saikhowa National Park. Pp. 110-111. *In*: Proc. Integration of fish biodiversity conservation through community participation (Ed: Mahanta, P.C.). NBFGR Publication, Lucknow.

WAKID, A. & S.P. BISWAS (2002): Sustainable development of Aquatic Resource of Dibru-Saikhowa Biosphere Reserve of Eastern Assam. *In*: Proc. National Seminar on Biodiversity Conservation vis-à-vis Sustainable Development, 29-30th August, 2002, North Lakhimpur. Published by N.L. College. Pp. 49.

YADAVA, Y.S. & R. CHANDRA (1994): Some threatened carps and catfishes of Brahmaputra river system. Pp. 45-55. *In*: Threatened Fishes of India (Eds: Dehadrai, P.V., P. Das & S.R. Verma). Natcon publication, Muzaffarnagar, 4.

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HILL STREAM FISHES OF THE NORTHERN PART OF UKHRUL DISTRICT, MANIPUR[1]

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A survey of the fish fauna of the northern part of Ukhrul district of Manipur has been undertaken. A total of 44 species belonging to 25 genera and 9 families have been recorded. The fauna is a mixture of endemic hill stream, Burmese, Indochinese and widely distributed forms.

Key words: Hill stream fishes, Ukhrul district, Manipur

INTRODUCTION

The northern part of the Ukhrul district of Manipur is drained by the Chalou (Chammu river) and Laniye rivers, which originate at about 2,616 m above msl. The Laniye river, which is formed mainly by three brooks, namely Akbong lok ('lok' means brook in Manipuri), Masangkong lok and Langdang Turel, meets the Zerry lok, which comes from eastern side of Senapati district of the state. It then flows northeast forming the state boundary between Manipur and Nagaland. Later, the river meets the Tizu river of Nagaland near Jessami. Further, Tizu river meets the Chalou river at Akash Bridge. Important tributaries of the Chalou river are Sirohi lok, Poi, Wanze, Ringnga, Momo, and Riori. Tizu river finally joined the Chindwin river in Myanmar. In this part of the state, the monsoon is quite prominent and maximum rainfall occurs in June (Singh 1989). The soil of this region is red loamy and slightly acidic.

Despite the occurrence and distribution of a vast network of rivers and streams in this part of Ukhrul district, which are totally isolated from the other rivers of the state, there is no detailed information on its fish fauna. The earliest available literature on the fishes of Ukhrul district was that of Chaudhuri (1912). The report of Hora (1937) on the fishes of upper Chindwin drainage was based on collections from the Khunukong and Namya rivers, which are in eastern Ukhrul. The present paper reports the fishes of the northern part of Ukhrul district, which is drained by the Chalou and Laniye rivers.

MATERIAL AND METHODS

Fishes were collected from the hill streams of northern part of Ukhrul district at six stations, namely Chingai, Khamsom, Jessami, Thetsi, Tolloi and Tusom CV during 1995-1998 (Fig. 1). All the specimens are preserved in 10% formalin and deposited in the Manipur University Museum of Fishes (MUMF). Fishes were identified following Jayaram (1981), Talwar and Jhingran (1991) and other relevant literature. The species were confirmed by comparing them with the type and other specimens in the Zoological Survey of India, Kolkata.

RESULTS AND DISCUSSION

Species-wise distribution of fishes in different localities in the northern part of Ukhrul district, Manipur, along with the total number of specimens examined for taxonomic study are given in Table 1. The present collection includes 44 species belonging to 25 genera, 9 families and 3 orders. The Order Cypriniformes represented maximum number of species (33), followed by Siluriformes (9) and Perciformes (2). Among the 25 genera, *Garra* showed maximum diversity, which was represented by 8 species, the next genus being *Schistura* with 5 species.

The collection included groups of fishes both with and without specific devices for adaptation in torrential water. *Semiplotus*, *Schizothorax*, *Barilius*, *Tor*, *Neolissochilus*, *Raiamas*, *Bangana*, *Brachydanio*, and *Danio* are genera with no special modifications, except for compression of body, with rounding off and tapering towards the anterior and posterior extremities. On the other hand, *Glyptothorax*, *Pseudecheneis*, *Garra*, *Myersglanis*, and *Schistura* are genera with special structural modifications. Similar observations in conformity with those of Hora (1922) were made in respect to the adaptations of the fishes to torrential stream habitats. The study sites have an altitudinal variation from 544 m above msl to 2,616 m above msl. Accordingly, the gradient of water current varies and also distribution of fishes. Species of genera such as *Barilius*, *Mastacembelus*, *Semiplotus*, *Neolissochilus*, *Tor*, *Schizothorax*, *Poropuntius*, *Garra*, *Schistura*, *Channa*, *Glyptothorax*, *Lepidocephalus*, and *Amblyceps* were found to be widely distributed. Some fishes like *Brachydanio*, *Danio*, *Esomus* and *Puntius* inhabit shallow waters with moderate to

Table 1: Species-wise distribution of fishes in different localities in the northern part of Ukhrul district, Manipur (N is the total number of specimens examined for taxonomic study)

Scientific Name	Local Name	Distribution						N	Remarks
		Chingai	Khamsom	Jessami	Thetsi	Tolloi	Tusom CV		
Order: Cypriniformes									
Family: Cyprinidae									
Subfamily: Cyprininae									
1. *Bangana dero* (Hamilton)	Allah/Khabak	-	-	1	1	-	-	2	M
2. *Neolissochilus hexagonolepis* (McClelland)	Khaicham/ Ngara	1	2	2	4	-	7	16	FP, W
3. *Neolissochilus stracheyi* (Day)	Khaicham/ Ngara	-	-	4	-	-	-	4	FP
4. *Puntius sophore* (Hamilton)	Khaiwonla/ Phabounga	-	-	-	2	-	-	2	-
5. *Puntius ticto ticto* (Hamilton)	Khaiwonla/ Ngakha	4	-	-	-	3	-	7	-
6. *Poropuntius burtoni* (Mukerji)	Rar/ Ngapeila/ Aasho	-	5	1	5	-	-	11	FP, W
7. *Semiplotus manipurensis* Vish. & Kosygin	Khi-Lu-Nu/ Igella/ Ngakoi	5	2	-	14	-	-	21	FP, W
8. *Tor putitora* (Hamilton)	Khihue/ Ngara	-	-	-	4	-	1	5	FP
9. *Tor tor* (Hamilton)	Khihue/ Ngara	-	-	-	2	-	3	5	FP
Subfamily: Rasborinae									
10. *Barilius barna* (Hamilton)	Marei/ Abhishi/ Ngawa	-	-	-	-	-	1	1	-
11. *Barilius ngawa* Vish. & Manoj.	Marei/ Abhishi/ Ngawa	-	1	4	16	-	10	31	FP, W
12. *Brachydanio acuticephalus* (Hora)	Nunga	5	-	-	-	-	-	5	-
13. *Danio aequipinnatus* McClelland	Khipuli/ Nunga	-	-	-	4	-	2	6	-
14. *Danio naganensis* Chaudhuri	Khipuli/ Nunga	2	3	1	4	-	7	17	W, EMN
15. *Esomus danricus* (Hamilton)	Muhialei/ Ngasang	-	-	-	-	-	3	3	-
16. *Raiamas guttatus* (Day)	Abhishi/ Ngawathongong	-	-	-	1	-	-	1	M
Subfamily: Schizothoracinae									
17. *Schizothorax richardsonii* (Gray)	Majong/ Vansu/ Sananga	1	3	-	-	3	2	9	FP, W
Subfamily: Garrinae									
18. *Crossocheilus burmanicus* Hora	Ungri/ Ngaroi	-	-	1	-	-	-	1	R
19. *Garra compressus* Kosygin & Vish.	Masah/ Ngamusangum	-	3	-	-	-	-	3	-
20. *Garra elongata* Vish. & Kosygin	Masah/ Ngamusangum	-	-	-	-	4	-	4	-
21. *Garra gotyla gotyla* (Gray)	Matrao/ Ngamusangum	-	-	-	-	-	3	3	-
22. *Garra kempi* Hora	Matrao/ Ngamusangum	1	3	-	1	-	-	5	-
23. *Garra lissorhynchus* (McClelland)	Matrao/ Ngamusangum	2	10	3	2	-	-	17	W
24. *Garra naganensis* Hora	Matrao/ Ngamusangum	4	3	-	9	1	1	18	W
25. *Garra nasuta* (McClelland)	Matrao/ Ngamusangum	1	1	2	3	-	-	7	W
26. *Garra* sp.1	Matrao/ Ngamusangum	-	-	-	-	-	2	2	-
Family: Balitoridae									
Subfamily: Balitorinae									
27. *Balitora brucei* (Gray)	Lungvap	-	3	-	-	-	-	3	-
Subfamily: Nemacheilinae									
28. *Schistura manipurensis* (Chaudhuri)	Moremlei/ Khirilei/ Ngatup	7	6	-	15	1	-	29	W, EMN
29. *Schistura nagaensis* (Menon)	Moremlei/ Khirilei/ Ngatup	-	15	-	5	2	2	24	NrM, EMN
30. *Schistura prashadi* (Hora)	Moremlei/ Khirilei/ Ngatup	-	1	-	4	-	3	8	EMN
31. *Schistura sikmaiensis* (Hora)	Moremlei/ Khirilei/ Ngatup	-	-	-	5	-	-	5	-
32. *Schistura vinciguerrae* (Hora)	Moremlei/ Khirilei/ Ngatup	-	10	-	-	-	-	10	-

Table 1: Species-wise distribution of fishes in different localities in the northern part of Ukhrul district, Manipur (N is the total number of specimens) (*contd.*)

Scientific Name	Local Name	Distribution						N	Remarks
		Chingai	Khamsom	Jessami	Thetsi	Tolloi	Tusom CV		
Family: Cobitidae									
Subfamily: Cobitinae									
33. *Lepidocephalicthys guntea* (Hamilton)	Khutha/ Khirilei/ Ngakijou	1	-	-	2	2	3	8	W
Order: Siluriformes									
Family: Bagridae									
34. *Mystus bleekeri* (Day)	Khithea/ Ngasep	-	-	-	1	-	-	1	-
Family: Siluridae									
35. *Ompok bimaculatus* (Bloch)	Khitu/ Ngaten	-	-	1	-	-	-	1	-
Family: Amblycepidae									
36. *Amblyceps mangois* (Hamilton)	Corelei/ Akhuterapu	3	7	1	6	-	8	25	W
Family: Sisoridae									
37. *Glyptothorax manipurensis* Menon	Igesha/ Ngapang	-	3	3	4	-	-	10	EMN
38. *Glyptothorax* sp.1	Igesha/ Ngapang	-	-	-	1	-	-	1	-
39. *Glyptothorax* sp. 2	Igesha/ Ngapang	-	-	-	1	-	-	1	-
40. *Glyptothorax* sp. 3	Igesha/ Ngapang	-	-	-	-	-	1	1	-
41. *Myersglanis jayarami* Vish. & Kosygin	Akhuterapu	-	-	8	-	-	-	8	-
42. *Pseudecheneis sulcatus* McClelland	Kaparong/ Khikha	-	1	-	-	-	1	2	R
Order: Perciformes									
Family: Channidae									
43. *Channa orientalis* (Bloch)	Kameikhi/ Meitei Ngamu	3	7	-	3	6	-	19	W
Family: Mastacembelidae									
44. *Mastacembelus armatus* (Lacèpéde)	Marui/ Ngaril	5	6	2	2	3	9	27	W, FP

Note: EMN = Endemic in Manipur and Nagaland; Nr M = New record from Manipur; W = Widely distributed; FP = High fishery potential in the study area

high current. In the first two genera, the lateral line perforation curves downward to help the fishes to live in shallow waters. Fishes that inhabited very strong current were found to belong to genera *Pseudecheneis*, *Balitora* and *Myersglanis*. They possess a series of transverse folds on the chest region, which help to attach them to the substratum, so as to withstand strong water currents. The species which were recorded only at low altitude with slower water current represented the genera *Mystus*, *Ompok*, and *Crossocheilus*. However, it is interesting to observe that fishes like *Bangana dero* and *Raiamas guttatus* were found only during June to August. It appears these fish inhabit larger rivers (Chindwin river) in Myanmar and migrate upstream during the monsoon.

The cobitid fish *Schistura nagaensis*, which was known only from Nagaland (India) is collected here for the first time from Manipur (Chindwin drainage). Menon (1987) described the fish from Phodung river in Nagaland. He distinguished it from its closest congeners *S. kangjupkhulensis* Hora (1921) in having 8 branched dorsal fin rays (vs. 7 in *S. kangjupkhulensis*). Kottelat (1990) tentatively considered *S. nagaensis* as a synonym of *S. kangjupkhulensis*, as he doubted the presence of 8 branched dorsal fin-rays in it. Further, he felt that the taxonomic status of *S. nagaensis* should be verified after examining fresh material. During the present study, 24 specimens of *Schistura*, which agree well with the description

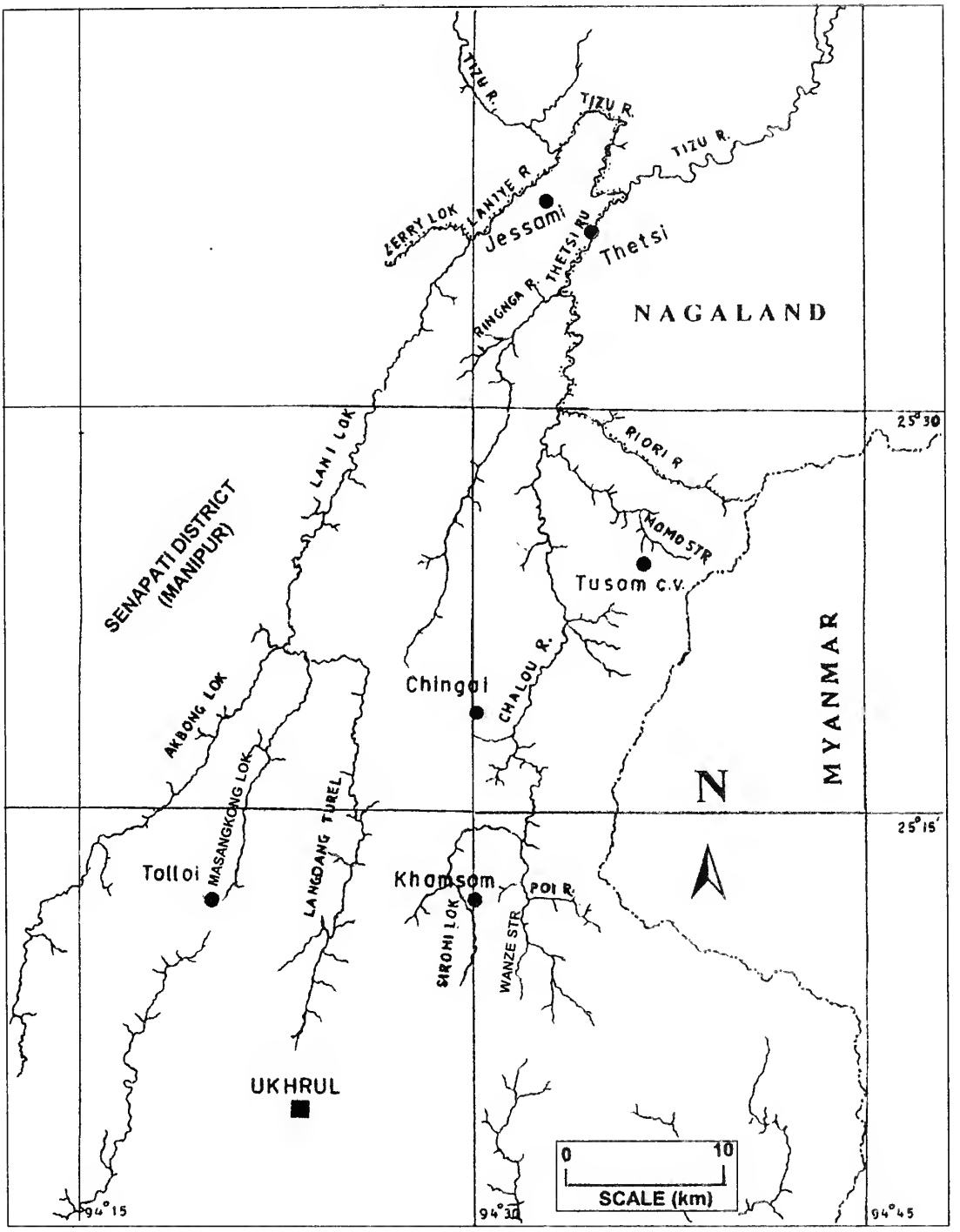

Fig. 1: Map of northern part of Ukhrul district, Manipur, showing drainage and study sites

of *S. nagaensis*, were collected from three different localities which are drained by the Tizu river. All the specimens were found to have 8 branched dorsal fin-rays. Two specimens of *S. nagaensis*, in the Zoological Survey of India (Regn. No. F 10061/1 and F 10067/2), which were collected with the type specimen in 1927, were re-examined and found to have 8 branched dorsal fin-rays. Thus, the presence of 8 branched dorsal fin-rays is a prominent character of *S. nagaensis* (Menon). The present collection also includes large, commercially important fishes like *Tor tor*, *Neolissochilus hexagonolepis*, *Schizothorax richardsonii*, *Semiplotus manipurensis*, and *Bangana dero*, which inhabit the Himalayan foothills. This shows the potential for hill stream fishery in this part of the State.

Of the 44 species reported here, 26 are also distributed in the Brahmaputra drainage, while 18 species are found only in the Chindwin drainage of Manipur. The 18 species are *Balitora brucei*, *Brachydanio acuticephala*, *Crossocheilius burmanicus*, *Neolissochilus stracheyi*, *Propuntius burtoni*, *Raiamas guttatus*, *Schistura vinciguerrae*, *Schistura nagaensis*, *Schistura prashadi*, *Barilius* sp. *Garra compressus*, *G. elongata*, *Garra* sp. *Glyptothorax* sp.1, *Glyptothorax* sp.2, *Glyptothorax* sp.3, *Myersglanis jayarami*, and *Semiplotus manipurensis*. The restricted distribution of these fishes shows that they evolved in the system comparatively late during the orogenic movements in this part of the world. At present there is no water connection between the Chindwin-Irrawady and Barak-Brahmaputra drainages as they are entirely separated by mountain ranges (Chaudhuri 1919). However, the widely distributed fishes were probably distributed when there was water connection between the Tsangpo and the Chindwin river as per the post-Himalayan river system hypothesis by Gregory (1925). When a connection between Tsangpo and Ganga-Brahmaputra was established, the fishes might have got distributed to other parts of the country.

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We are grateful to Dr. K.C. Jayaram, Jt. Director (Retd.), Zoological Survey of India (ZSI) for literature and encouragement in this work. We are also grateful to Dr. J.R.B. Alfred, Director, ZSI for permission to examine the types and other specimens in the Indian Museum and to the staff members of the Fish Section of ZSI for their co-operation during the first author's study in the Museum.

REFERENCES

CHAUDHURI, B.L. (1912): Description of some new species of freshwater fishes from North India. *Rec. Indian Mus. 7*: 437-444, pl. 38-41.

CHAUDHURI, B.L. (1919): Report on a small collection of fish from Putao (Hkamti Long) on the northern frontier of Burma. *Rec. Indian Mus. 16 (4)*: 271-282.

GREGORY, J.W. (1925): The evolution of the river system of south-eastern Asia. *Scottish Geogr. J. 41*: 129-141.

HORA, S.L. (1921): Fish and fisheries of Manipur with some observations on those of Naga Hills. *Rec. Indian Mus. 22*: 165-214.

HORA, S.L. (1922): Structural modifications in the fish of mountain torrents. *Rec. Indian Mus. 24*: 31-61.

HORA, S.L. (1937): On a small collection of fish from the upper Chindwin drainage. *Rec. Indian Mus. 39*: 331-338.

JAYARAM, K.C. (1981): Freshwater fishes of India, Pakistan, Bangladesh, Burma, and Sri Lanka. Handbook, Zoological Survey of India, Calcutta, 475 pp.

KOTTELAT, M. (1990): Indochinese nemacheilines, A revision of nemacheiline loaches (Pisces: Cypriniformes) of Thailand, Burma, Laos, Cambodia and South Vietnam. Verlag Dr. Friedrich Pfeil, München, 262 pp, figs. 1-180.

MENON, A.G.K. (1987): The fauna of India and adjacent countries, Pisces Vol 4, No. 1. Zoological Survey of India, Calcutta, 259 pp, 16 pls.

SINGH, T.B. (1989): Population dynamics, biomass and secondary productivity of above ground insects in the sub-tropical forest ecosystem at Shiroy hills, Manipur. Ph.D. Thesis, Manipur University, 326 pp.

TALWAR, P.K. & A.G. JHINGRAN (1991): Inland fishes of India and adjacent countries, I, Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi. 541 pp.

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VALIDITY AND REDESCRIPTION OF *GLYPTOTHORAX MANIPURENSIS* MENON AND RECORD OF *G. SINENSE* (REGAN) FROM INDIA[1]

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Glyptothorax manipurensis Menon, originally described from Barak-Brahmaputra drainage of Manipur (India), has hitherto been considered a junior synonym of *G. sinense* (Regan). Based on the type specimens and 7 specimens collected recently from Ukhrul district, Manipur (Chindwin drainage), *G. manipurensis* Menon is redescribed here as a valid species. It is distinguished from *G. sinense* in having a more broadly rounded snout, broader head, wider teeth band, origin of rayed dorsal fin equidistant between snout tip and adipose dorsal fin (vs. nearer snout tip than adipose dorsal fin), a caudal fin spotted or dusky with black spots (vs. plain) and granulated skin (vs. smooth). *G. sinense* (Regan) hitherto known from China and Myanmar is recorded here for the first time from India. The distribution of both the species is discussed.

Key words: New record, redescription, *Glyptothorax sinense*, *G. manipurensis*

INTRODUCTION

Menon (1954) described *G. manipurensis* from Karong (Brahmaputra basin), Manipur, India. He distinguished it from its closest congener *G. sinense* (Regan) by its broader head and presence of black colour at the base of the dorsal fin, adipose dorsal fin and caudal fin. Misra (1976) and Talwar and Jhingran (1991) considered *G. manipurensis* as a junior synonym of *G. sinense* and extended the distribution of the latter to India. However, Jayaram (1979) recognised two subspecies within this species, namely *G. sinense sinense* (Regan) and *G. sinense manipurensis* Menon. Kosygin and Vishwanath (1998) reported *G. sinense manipurensis* for the first time from Nagaland (Chindwin drainage), India.

Regan (1908) described *Glyptothorax sinense* based on a single specimen collected from Tungting, China. Tung-t'ing (= Tungting or Dongting) lake is in the valley of the Yangzi (=Yangtze) river in the northern Hunan province in southeast China. Mukerji (1933) reported the species for the first time from the Mali-Hka river. He remarked that J.R. Norman confirmed the specimen, which is in the Zoological Survey of India, Kolkata (ZSI F 11444/1), as *G. sinense* after comparing it with the type specimen in the British Museum of Natural History.

In the present study, eight specimens of *Glyptothorax* were collected from the Ukhrul district of Manipur, which is drained by the Chindwin-Irrawaddy drainage. Out of these, seven specimens agree with the description of *G. manipurensis* Menon, while one specimen agrees with *G. sinense* (Regan). In the present paper, *G. sinense* is reported for the first time from India and *G. manipurensis* Menon, 1954 is redescribed as a valid species.

MATERIAL AND METHODS

Specimens collected during the present study have been deposited in the Manipur University Museum of Fishes (MUMF). Specimens of the present collection were compared for confirmation with the type and other specimens of *Glyptothorax* in the Zoological Survey of India, Kolkata (ZSI). Measurements and counts follow Jayaram (1981). Measurements were made with dial calipers (Mitutoyo, Japan) to the nearest 0.1 mm, and body proportions are expressed as percentage of standard length (SL) or head length (HL).

Glyptothorax manipurensis Menon 1954

Glyptothorax manipurensis Menon 1954, *Rec. Indian Mus.* 52 (1): 23 (type locality: Barak river at Karong, Manipur).

Glyptothorax sinense manipurensis: Jayaram, 1979, *Occ. Paper, Zool. Surv. India*, 14: 1-62.

Material examined: ZSI F 738/2, Holotype, 74.5 mm SL, Barak R. (Brahmaputra basin), Karong, Naga hills, Manipur, India, Coll. A.G.K. Menon and party, February, 1953; ZSI F 743/2, 1 ex., 54.0 mm SL, Paratype (Figured in original description), same data as Holotype. MUMF 2027, 1 ex., 89.0 mm SL, Laniye river near Jessami (Chindwin basin), Manipur-Nagaland state border, India, Coll. L. Kosygin, February 28, 1994; MUMF 2103-2104, 2 exs., 80.5-90.0 mm SL, Laniye river near Jessami, Manipur-Nagaland state border, India, Coll. L. Kosygin, May 31, 1994; MUMF 2190-2193, 4 exs., 74.0-108.0 mm SL, Tizu River (Chindwin basin), Akash Bridge, near Thetsi, Manipur-Nagaland state border, India, Coll. L. Kosygin, August 15,1994.

Diagnosis: A species of *Glyptothorax* with the

following combination of characters: Head large, broad (width 21.1-22.8% SL, 86.5-94.4% HL); broadly rounded snout (length 11.1-12.9% SL, 46.1-50.0% HL); rayed dorsal fin origin equidistant between snout tip and adipose dorsal fin; predorsal length 34.0-36.2% SL; occipital process does not reach basal bone of rayed dorsal fin; dorsal spine serrated posteriorly; 8-9 branched anal fin rays; granulated skin.

Description: Morphometric data are shown in Table 1 and general body shape in Fig 1. Rayed dorsal fin with 1 simple and 5-6 branch rays. Anal fin with 2 simple and 8-9 branched rays. Caudal fin forked, with 17 principal rays. Pectoral fin with one simple and 9 branched rays. Pelvic fin with 6 rays. Lateral line distinct. Body elongate, compressed dorso-ventrally, from head to anal fin. Caudal peduncle slightly compressed laterally. Head wide, almost as long as wide. Snout broadly rounded. Eye moderate, not visible from ventral side, in posterior half of head. Mouth inferior, horizontal, lips papillated. Teeth villiform, those on upper jaw form a wide, continuous band, while band in lower jaw is interrupted in the middle. Barbels four pairs. Maxillary barbels reach middle of pectoral fin base. Outer mandibular barbels reach upper angle of gill opening. Inner mandibular barbels reach anterior margin of thoracic adhesive apparatus. Nasal barbels reach anterior margin of orbit. Occipital process distinctly separated from basal bone of dorsal fin. Thoracic adhesive apparatus triangular, longer than broad with slight depression in the middle (Fig. 2). Dorsal spine strong, osseous, serrated posteriorly, its origin equidistant between snout tip and adipose dorsal fin. Pectoral fins with an internally denticulated spine. Paired fins non-plaited. Skin granulated.

Proportional measurements in percentage [mean (range) ±standard deviation]: Body depth 21.2 (16.9-25.0 ±2.6) of SL, head length 24.6 (22.7-25.9 ±0.9), head width 21.8 (21.1-22.8 ±0.6), snout length 11.9 (11.1-12.9 ±0.6), caudal peduncle length 20.0 (18.1-22.1 ±1.3), caudal peduncle height 9.2 (8.3-10.1 ±0.6), predorsal length 35.1 (34.0-36.5 ±0.9), dorsal fin height 20.5 (19.4-22.9 ±1.1), dorsal spine length 18.2 (16.2-22.9 ±2.2), adipose dorsal fin length 15.3 (12.3-18.9 ±2.2), adipose

Table 1: Comparison of proportional measurements of *Glyptothorax manipurensis* Menon and *G. sinense* Regan

	G. manipurensis				*G. sinense*	
	ZSI F 738/2 Holotype (Brahmaputra basin)	ZSI F 743/2 Paratype (Brahmaputra basin)	MUMF 2027, 2103, 2104, 2190- 2193 Mean (range) (Chindwin basin)	sd	ZSI F 11444/1 (Irrawaddy basin)	MUMF 2244 (Chindwin basin)
Standard Length	74.5	54.0	87.3 (74.0 - 108.0)	11.2	102.0	98.3
In % of SL						
Head length	24.2	25.9	24.4 (22.7 - 25.7)	0.9	22.1	23.4
Head width	22.8	22.2	21.6 (21.1 - 22.3)	0.4	18.1	19.8
Snout length	12.1	12.9	11.7 (11.1 - 12.5)	0.5	10.3	10.7
Body depth	19.5	18.5	21.8 (16.9 - 25.0)	2.7	15.7	21.8
Caudal peduncle length	18.1	18.5	20.5 (19.2 - 22.1)	1.0	20.6	20.7
Caudal peduncle height	10.1	8.3	9.2 (8.7 - 10.1)	0.5	6.4	9.7
Predorsal length	36.2	36.1	34.8 (34.0 - 36.2)	0.7	33.8	32.6
Dorsal fin height	20.8	20.4	20.5 (19.4 - 22.9)	1.3	17.6	20.0
Dorsal spine length	18.8	17.6	18.2 (16.2 - 22.9)	2.6	13.2	16.3
Adipose dorsal fin length	13.4	13.3	15.9 (12.3 - 18.9)	2.2	12.7	18.1
Adipose dorsal fin height	4.3	4.0	5.3 (4.6 - 5.8)	0.5	2.9	5.5
Pectoral fin length	22.1	22.2	23.3 (21.7 - 25.0)	1.3	21.6	23.2
Anal fin base length	14.8	13.1	14.3 (12.9 - 15.7)	1.1	11.8	15.5
Anal fin height	17.4	18.0	18.5 (16.2 - 19.2)	1.1	16.7	17.3
Caudal fin length	25.5	-	24.4 (22.3 - 28.1)	2.3	-	23.6
In % of HL						
Head height at occiput	61.1	60.7	65.5 (60.5 - 73.9)	4.9	53.3	63.5
Head width	94.4	86.5	88.4 (86.4 - 93.9)	2.6	82.2	84.8
Eye diameter	13.9	14.3	13.1 (10.9 - 16.3)	2.0	8.9	14.8
Inter-orbital space	27.8	22.8	26.2 (22.5 - 28.3)	2.1	28.9	26.1
Adhesive apparatus length	63.9	-	59.6 (56.4 - 65.2)	3.0	62.2	64.8
Adhesive apparatus width	44.4	-	48.1 (43.6 - 54.3)	4.0	48.9	55.2
Snout length	50.0	50.0	47.9 (46.1 - 50.0)	1.2	48.8	46.1
In % of caudal peduncle length						
Caudal peduncle height	55.5	45.0	44.4 (41.2 - 51.4)	3.7	33.3	46.6

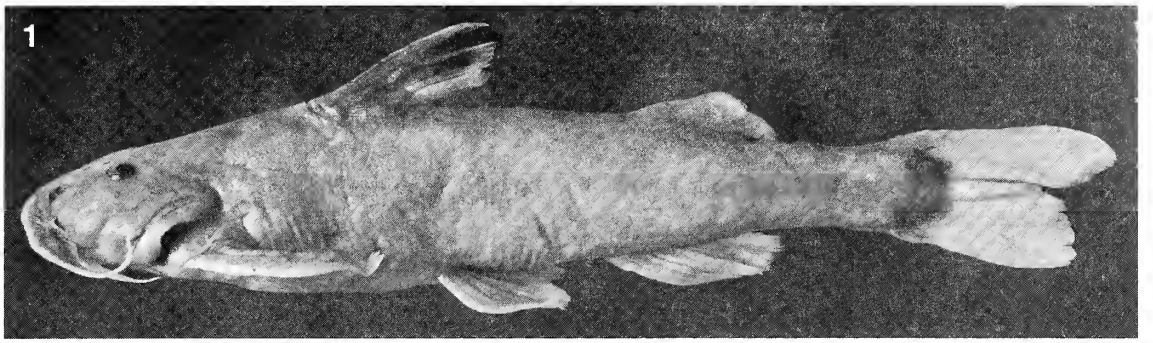

Fig. 1: *Glyptothorax manipurensis* Menon, lateral view (MUMF 2190, 108.0 mm SL)

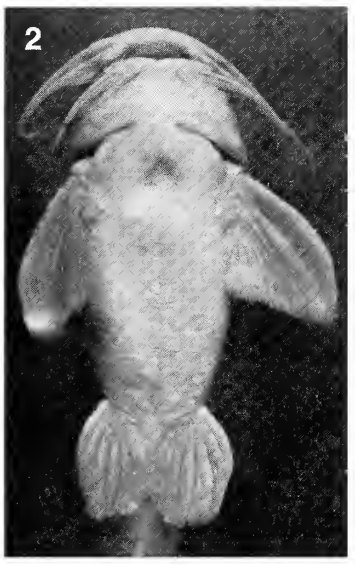

Fig. 2: *G. manipurensis* Menon, ventral view (MUMF 2190, 108.0 mm SL)

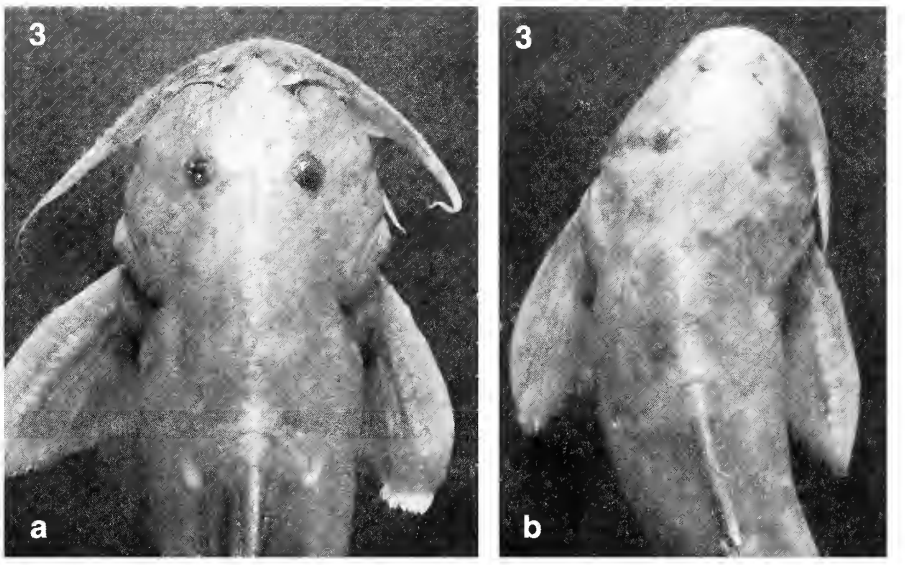

Fig. 3: Comparison of head shape:
a. *G. manipurensis* (MUMF 2190, 108.0 mm SL);
b. *G. sinense* (MUMF 2244, 98.3 mm SL)

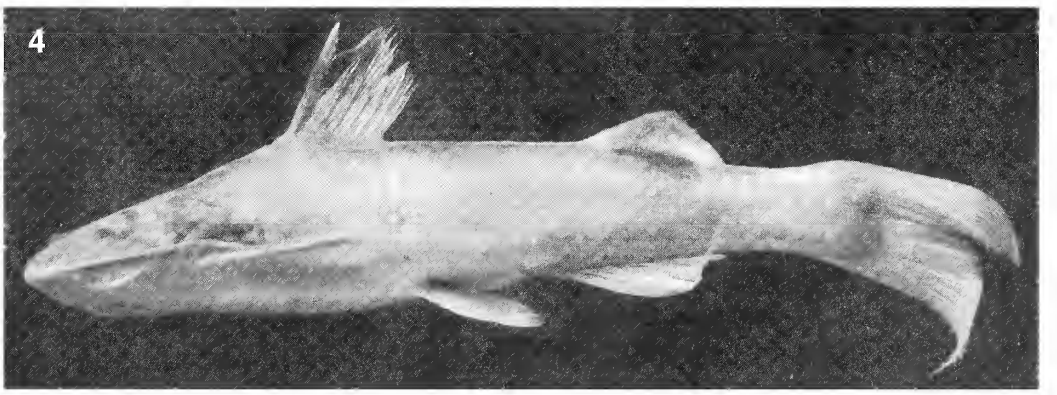

Fig. 4: *Glyptothorax sinense* (Regan) (MUMF 2244, 98.3 mm SL)

dorsal fin height 4.9 (4.0-5.8 ±0.7), pectoral fin length 23.0 (21.7-25.0 ±1.2), ventral fin length 16.3 (14.8-17.4 ±0.7), anal fin base length 14.2 (12.9-15.7 ±1.1), anal fin height 18.3 (16.2-19.2 ±1.0), caudal fin length 24.6 (22.3-28.1 ±2.1). Head width 88.9 (86.5-94.4 ±3.1) of HL, head height at occiput 64.5 (60.5-73.9 ±4.7), eye diameter 13.3 (10.9-16.3 ±1.8), interorbital space 26.0 (22.5-28.3 ±2.3), snout length 48.4 (46.1-50.0 ±1.4), adhesive apparatus length 60.1 (56.4-65.2 ±3.3), adhesive apparatus width 47.7 (43.6-54.3 ±4.0). Caudal peduncle height 45.9 (41.2-55.5 ±4.9) of its length.

Colour: Body grey to olivaceous dark brown with dark patches at the base of rayed dorsal fin, adipose dorsal fin, and caudal fins. Rayed dorsal fin with a broad longitudinal black band in the middle. Caudal fin is dusky or with black dots.

Distribution: INDIA: Barak R., (Brahmaputra basin), Karong, Senapati district, Chalou R., (Chindwin basin), Ukhrul district, Manipur.

Remarks: Menon (1954) distinguished *Glyptothorax manipurensis* from its closest congener *G. sinense* by its broader head and presence of black colour at the base of dorsal fin, adipose dorsal fin and caudal fin. In the present study, the first character holds true (Fig. 3), but the second character seems to be misleading because the specimens of *G. sinense* also have similar faint dark patches, even though the markings are more distinct in *G. manipurensis*. He further erroneously described the nature of the skin as smooth. However, in the present study, the type specimen of the fish in the ZSI and specimens collected from the Chindwin basin were examined and found to have granulated skin in all the specimens. Based on the present study, *G. manipurensis* is distinguished from *G. sinense* in having granulated skin (vs. smooth), broadly rounded snout (vs. slightly conical snout), broader head (head width 21.1-22.8% SL vs. 18.1; 86.5-94.4% HL vs. 82.2), longer snout (11.1-12.5% SL vs. 10.3), origin of rayed dorsal fin equidistant between snout tip and adipose dorsal fin (vs. nearer snout tip than adipose dorsal fin), and a caudal fin spotted or dusky with black spots (vs. plain). The fish is similar to *G. trilineatus* (Blyth) in having granulated skin on the body and head. However, *G. manipurensis* is easily distinguished from *G. trilineatus* in having a body without any longitudinal bands on its body (vs. three longitudinal bands on the body of the latter). *G. manipurensis* is so far known only from Manipur and Nagaland in India.

Other material examined: *Glyptothorax sinense*: ZSI F 11444/1, 1 ex., Phungin Hka, Myitkyina district, Myanmar. *G. burmanicus*: ZSI F 10877/1, 1 ex., Myitkyina district, Myanmar, Prashad & Mukherji. *G. cavia*: MUMF 2500, 3 ex., Manipur, India. *G. trilineatus*: ASB (Asiatic Society of Bengal) Cat. 581, 1 ex., paratype, Tenasserim, Myanmar. *G. pectinopterus*: ZSI F 216/2, 1 ex., Kangra valley, India. *G. gracile*: ZSI F 2479/2, 1 ex., Kameng, India. *G. saisii*: ZSI F 25837, holotype, Parasnath hills, India. *G. telchitta*: ZSI F 239/2, 1 ex., Darbhanga, India. *G. prashadi*: ZSI F 10845/2, 1 ex., Sritamarat, Siam.

Glyptothorax sinense (Regan, 1908)

Glyptosternon sinense Regan, 1908, *Ann. Mag. nat. Hist.* (8)11: 110 (type locality: Tungting, China).

Glyptothorax sinense: Mukerji, 1933, *J. Bombay Nat. Hist. Soc.*, 36: 280, pl. 2, fig. 1 (Phungting Hka, tributary of Mali Hka River, Upper Burma).

Material examined: ZSI F 11444/1, 1 ex., 102.0 mm, Phungin Hka, tributary of Mali Hka river, Myitkyina district, Myanmar, Coll. Lt. Col. R.W. Burton, no date. MUMF 2244, 1 ex., 98.3 mm SL, India: Tizu River (Chindwin basin), Akash Bridge near Thetsi, Manipur-Nagaland state border, India, Coll. L. Kosygin, August 7, 1995.

Diagnosis: A species of *Glyptothorax* with the following combination of characters: Head small, conical (width 18.1-19.8% SL; 82.2-84.8% HL); more or less pointed snout (length 10.3-10.7% SL); dorsal fin origin nearer snout tip than adipose dorsal fin; occipital process does not reach basal bone of rayed dorsal fin; dorsal spine serrated posteriorly; 9-10 branched anal fin rays; soft and smooth skin.

Description: Morphometric data are given in Table 1 and general body shape in Fig. 4. Rayed dorsal fin with 1 simple and 6 branch rays. Anal fin with 2 simple and 9 branched rays. Caudal fin forked, with 17 principal rays. Pectoral fin with one simple and 9 branched rays. Pelvic fin with 6 rays. Lateral line distinct. Body elongate. Head depressed, conical, longer than broad. Snout broadly rounded. Eye of moderate size, almost in the middle of head, not visible from ventral side. Mouth inferior, upper jaw longer, lips papillated. Four pairs of barbels. Maxillary barbels with broad bases, reaching posterior base of pectoral spine. Outer mandibular barbels reach origin of pectoral fin. Inner mandibular barbels much shorter than outer mandibular. Nasal barbels reach anterior margin of orbit. Nostril closer to snout tip than to orbit. Occipital process not reaching basal bone of dorsal fin. Thoracic adhesive apparatus rhomboidal, considerably longer than broad, without central pit. Dorsal spine strong, osseous, serrated posteriorly. Its origin nearer to snout tip than caudal fin base. Pectoral spine strong, osseous, with 10 sharp denticulations along the posterior edge. Adipose dorsal fin high, its origin opposite anal fin origin. Inter-dorsal wide, with a series of visible small spines below the skin. Skin smooth.

Colour: Body greenish-brown with irregular dark patches. Prominent deep brown patches present at the base of rayed dorsal fin, adipose dorsal fin and another less prominent one on caudal fin base. Dorsal fin with one broad black band. Other fins pale white.

Distribution: INDIA: Nagaland, Tizu River (Chindwin basin), Manipur; Myanmar: Mali Hka river (Irrawaddy basin); China: Dongting lake, Yangtze river basin.

Remarks: The present specimen of *G. sinense* collected from Manipur-Nagaland border (Chindwin basin) agrees with

the description of the species. However, while re-examining the Burmese specimen in the ZSI, differences were found in the body proportions and number of branched anal fin-rays, even though they possess the specific characters of *G. sinense*. Hora (1923) remarked that the members of the genus *Glyptothorax* are still in the process of adaptation to life in hill streams, and the specific characters in them have not yet stabilised. The variation in these two specimens may be due to the ecological factors of the different habitats that they inhabit, and they may be in the process of adaptation to their respective environments.

However, the occurrence of *Glyptothorax sinense* in two river basins, Yangtze drainage in China and Chindwin system in India and Myanmar, which are quite far apart, needs confirmation. As the type of *G. sinense* is not available for comparison, the identification of the species is based only on Mukerji's (1933) statement, Misra's (1976) description and comparison with Mukerji's collection of the fish from Myanmar (reported to have been compared with the only type in the British Museum by J.R. Norman). The fish from Manipur is presently placed under *G. sinense*, which is being reported for the first time from India in this paper.

ACKNOWLEDGEMENT

We are grateful to the Director, Zoological Survey of India (ZSI) for granting permission to re-examine the type and other specimens in the museum.

REFERENCES

HORA, S.L. (1923): Notes on fishes in the Indian Museum, 5. On the composite genus *Glyptosternum* McClelland. *Rec. Indian Mus. 25*: 1-44.

JAYARAM, K.C. (1979): Aid to the identification of the sisorid fishes of India, Burma, Sri Lanka, Pakistan and Bangladesh. 3, Sisoridae. *Zool. Surv. India Occ. Pap. 14*: 1-62.

JAYARAM, K.C. (1981): Freshwater fishes of India, Pakistan, Bangladesh, Burma, and Sri Lanka. Handbook, Zoological Survey of India, Calcutta, 475 pp.

KOSYGIN, L. & W. VISHWANATH (1998): A Report on Fish diversity of Tizu River, Nagaland with some new records. *Ecol. Env. & Cons. 4 (4)*: 243-247.

MENON, A.G.K. (1954): Further observation on the fish fauna of Manipur state. *Rec. Indian Mus. 52*: 21-26.

MISRA, K.S. (1976): The fauna of India and the adjacent countries, Pisces 3. Zoological Survey of India. 367 pp.

MUKERJI, D.D. (1933): Report on Burmese fishes collected by Lt. Col. R. W. Burton from the tributary streams of the Mali-Hka River of the Myitkyina district (upper Burma). *J. Bombay Nat. Hist. Soc. 36(4)*: 812-831.

REGAN, C.T. (1908): Description of three new freshwater fishes from China. *Ann. Mag. Nat. Hist. [Ser. 8] 1(1)*: 109-110.

TALWAR, P.K. & A.G JHINGRAN (1991): Inland fishes of India and adjacent countries, 1, Oxford and IBH Publ. Co. Pvt. Ltd., New Delhi. 541 pp.

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DIVERSITY OF SPIDERS IN KUTTANAD RICE AGRO-ECOSYSTEM, KERALA[1]

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The seasonal fluctuation in population of some important families of spiders in a rice agro-ecosystem of Kuttanad was studied during 1999 to 2001 by standard sweeping and handpicking method. The data was analyzed for species diversity, evenness and richness. Out of the four sampling sites, site-2 in upper Kuttanad exhibited maximum species diversity. A total of 22 species of 14 genera, from 8 families, were reported during the study period.

Key words: Kuttanad, rice, spider, diversity, evenness, richness

INTRODUCTION

Spiders are very important biological control agents in a rice agro-ecosystem and play a major role as defenders by suppressing the pest population to a safe level. This supports the concept of Integrated Pest Management (IPM) in modern agriculture. Presently there is a need to reduce pesticide usage on the world's crops and optimize natural biological control, for which full investigation of the means by which spiders control pest abundance is long overdue. More than 600 arthropod pest species regularly destroy more than 10% of our agricultural production (Samways 1997). Total reliance on synthetic pesticides entails severe and costly health, environmental and even pest management side effects (Newsome 1970). Spiders, despite their ubiquity and high densities, have not received due recognition as pest control agents, although their treatment in several recent compendia is encouraging (Toft and Riedel 1995). Over the last 35 years, field experiments have demonstrated that spiders can reduce insect populations and crop damage (Ito *et al.* 1962).

Study of spider community and species diversity is a pre-requisite to assess the role of spiders as biological control agents in any ecosystem. Spiders are known to play an important role in suppressing populations of Green Leaf Hopper (GLH), Brown Plant Hopper (BPH), White-backed Plant Hopper (WPH), and also certain dipterans, lepidopterans, coleopterans and orthopterans on paddy (Barrion 1980). Very little information is available on the spider population of the rice ecosystem in Kuttanad, except from the work of Sebastian and Chacko (1994), and Sudhikumar and Sebastian (2001). This work was carried out to study the population fluctuations and to estimate diversity and richness of spider species in Kuttanad rice agro-ecosystem.

STUDY AREA

Kuttanad is rightly called the "rice bowl" of Kerala, contributing nearly 20% of the total rice production of the State. The region extends from 9° 17' N to 9° 40' N and 76° 19' E to 76° 33' E. It is separated from the Arabian Sea by a narrow strip of land. Kuttanad is a deltaic formation of four river systems, namely Meenachil, Pamba, Manimala, and Achencovil, together with the low-lying areas in and around Vembanad lake. Most of the vast expanse of this region lies below mean sea level, is water logged almost throughout the year, submerged during the monsoon, with saline water ingression during the summer. It consists of 53,639 hectares distributed among 1086 units where rice is cultivated. It is a warm, humid region with fairly uniform temperature throughout the year, ranging from 21 °C to 36 °C. Humidity is generally very high throughout the year. The average annual rainfall is *c.* 300 cm, of which about 83% is received during the monsoon. The study was undertaken during the kharif (additional crop) and rabi (puncha) seasons (November to March and June to September respectively) of 1999, 2000 and 2001. Spiders were collected from four sampling sites of Kuttanad: Site-1 (Krishnapuram) and Site-2 (Pallikoottuma) from upper Kuttanad and Site-3 (Nedumudy) and Site-4 (Vellisrakka) from lower Kuttanad.

MATERIAL AND METHODS

Survey of Spiders

Spiders were collected fortnightly from four sampling sites during June, 1999 to March, 2001. Collections were made by the standard sweeping and handpicking methods. The collected specimens were killed in chloroform and preserved temporarily in 70% alcohol. These were sorted out by placing them in a petri dish containing 70% alcohol under a Stereo Zoom microscope (Leica MS 5); adult males and females were identified up to species level with the help of available literature (Tikader and Malhotra 1980; Tikader and Bal 1981; Tikader and Biswas 1981). Immature spiders were identified up to generic levels.

Quantitative estimation of species and individuals of spiders in different stages of crop growth was made, using the data derived from field surveys. Species diversity (H) was computed based on Shannon-Wiener formula (Kamal *et al.* 1992). Evenness (J) and richness (ma) were computed according to Pielou (1975).

RESULTS AND DISCUSSION

The present work, based on a critical study of different spider families, revealed that different groups were active at different times of the season, showing their prey preference at different stages of crop growth.

A total of 2708 spiders under 8 families, 14 genera and 22 species were collected during the study period. Of these, 24.03% of the spiders belonged to Family Tetragnathidae, representing genera *Dyschiriognatha* and *Tetragnatha*. *Tetragnatha listeri* was the most abundant species from this family. Family Araneidae contributed 23.52% and was represented by the genus *Araneus, Neoscona*, and *Cyclosa*. *Neoscona pavida* was the most abundant species of this family. Family Theridiidae contributed 21.27% and was represented by the genera *Phycosoma* and *Theridion*. Family Lycosidae contributed 18.57% and was represented by the genera *Evippa*, *Hippasa* and *Pardosa*. Others belonged to families Linyphiidae, Oxyopidae and Sparassidae.

The entire study was conducted during four different crop seasons. These include two rabi seasons (June-September) and two kharif (November-March) seasons. The first was from June 1999 to September 1999. Seven families were reported during this collection. The majority belonged to Family Araneidae (26.40%); other major families reported were Tetragnathidae (21.80%), Theridiidae (20.91%), Lycosidae (17.98%) and Salticidae (9.69%). The second season was from November 1999 to February 2000. A total of 588 spiders were collected during this period. The family composition reported was: Theridiidae 22.95%, Araneidae 22.44%, Lycosidae 21.42%, Tetragnathidae 18.53% and Salticidae 10.03%. The third season was from June 2000 to September 2000. A total of 663 spiders were collected during this period. The family composition reported was: Tetragnathidae 30.92%, Lycosidae 19.91%, Araneidae 18.85%, Theridiidae 18.70% and Salticidae 9.35%. The fourth season was from December 2000 to March 2001. A total of 673 spiders were collected during this period. The family composition reported was: Araneidae 25.70%, Tetragnathidae 24.66%, Theridiidae 22.73%, Lycosidae 15.45% and Salticidae 10.10%.

Analysis of Evenness, Species Diversity and Richness

Evenness, diversity and richness of spider species in four sampling sites are given in Table 1. The diversity index was highest (0.979) at Site-2 and lowest (0.488) at Site-3. Diversity was calculated with the help of two factors, species richness and evenness. Considerable discussion is going on about the measurement of diversity, which is directly correlated with the stability of the ecosystems, being higher in biologically controlled systems, and lower in polluted ecosystems (Rosenberg 1976).

Table 1: Total number of individuals in all species (N), number of species (S), evenness index (J), diversity index (H) and species richness index (ma) of four sampling sites during the study period

Sampling Sites	N	S	J	H	ma
Site-1	490	19	1.042	0.858	6.69
Site-2	460	21	1.113	0.979	7.51
Site-3	508	11	0.861	0.488	3.69
Site-4	303	12	1.063	0.689	4.43

The evenness index of Site-2 was highest (1.113) and that of Site-3 lowest (0.861) (Table 1). As evenness and species diversity are directly proportional, they showed the same pattern of expression in the study (Pearson 1977).

In case of species richness, site-2 had the highest index value and site-3 the lowest value (Table 1). A total of 950 spiders of 21 species were collected from upper Kuttanad. The values of J (1.113), H (0.979) and ma (7.51) from upper Kuttanad were slightly higher than lower Kuttanad. According to Boecklen and Simberloff (1986), habitat heterogeneity, in addition to area, is an important determinant of species richness.

According to Usher (1986), diversity is the most frequently adopted criterion for evaluation of conservation schemes. Diversity indices are directly correlated with the stability of the ecosystem and will be high in biologically controlled systems. All diversity indices have limitations because they attempt to combine a number of variables that characterise community structure.

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REFERENCES

BARRION, A.T. (1980): Taxonomy and Bionomics of spiders in Philippine Rice Agroecosystem: Foundation for future biological control efforts. *Proc. of the Nat. Conf. Pest Control Council of Philippines 11*: 1-39.

BOECKLEN, W.J. & D. SIMBERLOFF (EDS.) (1986): Area based extinction models. Conservation in dynamics of extinction. John Wiley and Sons, New York. 280 pp.

ITO, Y., K. MIYASHITHA & K. SEKIGUCHI (1962): Studies on the predators of the rice crop insect pest using the insecticidal check method. *Jap. J. Ecol. 12*: 1-11.

KAMAL, N.Q., A. BEGUM & V. BISWAS (1992): Studies on the abundance of spiders in rice ecosystem. *J. Ins. Sci. 5*: 30-32.

NEWSOME, L.D. (1970): The end of an era and future prospects for insect control. *Proc. Tall Timbers Conf. 3*: 117-136.

PEARSON, D. (1977): A pantropical comparison of bird community: Structure of six low land rain forest sites. *Condor 79*: 232-244.

PIELOU, E.C. (EDS.) (1975): Ecological Diversity. John Wiley and Sons, New York. 165 pp.

ROSENBERG, R. (1976): Benthic faunal dynamics during succession following pollution abatement in a Swedish estuary. *Oikos. 27*: 414-427.

SAMWAYS, M.J. (1997): Classical biological control and biodiversity conservation: What risks are we prepared to accept? *Biodiversity Conserv. 6*: 1309-1316.

SEBASTIAN, P.A. & ELIZABETH CHACKO (1994): Studies on the predatory spiders of paddy fields from Kuttanad. *Proc. 6th Kerala Sc. Congress. 6*: 377-378.

SUDHIKUMAR, A.V. & P.A. SEBASTIAN (2001): Studies on the spider fauna in rice field of Kuttanad, Kerala. *Proc. Biocontrol Pest Management for Quality Crop Protection in the Current Millennium. 1*: 31-32.

TIKADER, B.K. & A. BAL (1981): Studies on some orb weaving spiders of the genera *Neoscona* and *Araneus* of the family Araneidae (Argiopidae) from India. *Rec. zool. Surv. India. 24*: 1-60.

TIKADER, B.K. & B. BISWAS (1981): Spider fauna of Calcutta and vicinity. *Rec. zool. Surv. India. 30*: 1-149.

TIKADER, B.K. & M.S. MALHOTRA (1980): Fauna of India: Araneae. Zoological Survey of India, Calcutta. 443 pp.

TOFT, S. & W. RIEDEL (EDS.) (1995): Arthropod natural enemies in arable land. I, Density, spatial heterogeneity and dispersal. Aarhus. Univ. Press, Denmark. 314 pp.

USHER, M.B. (1986): Wildlife conservation and evaluation: Attributes, criteria and values in wildlife conservation and evaluation. Chapman and Hall, London. 394 pp.

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NEW DESCRIPTIONS

THREE NEW SPECIES OF GENUS *CLADARCTIA* KODA (ARCTIINAE: ARCTIIDAE: LEPIDOPTERA) FROM INDIA[1]

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Three new species of genus *Cladarctia* Koda *C. hansraji, C. discocellulatus* and *C. bharmourensis* are described from India. A key to Indian species of this genus is provided.

Key words: New species, *Cladarctia*, genitalia

INTRODUCTION

Koda (1988) erected a new genus *Cladarctia* on a single Indian species *Euprepria quadriramosa* Kollar. He distinguished the genus *Cladarctia* from the closely allied genus *Estigmene* Hübner on the basis of its male genitalic features like protuberate uncus and simple valva with well developed costa. As many as eight representatives of three species have been collected from different localities of Himachal Pradesh and Uttar Pradesh. The species could not be identified from literature (Hampson 1894, 1901) or from National Museums and the Natural History Museum, London. However, they completely conform to the characters of genus *Cladarctia* and are closely allied to its type species. These three distinct species are named *Cladarctia hansraji* n. sp., *C. discocellulatus* n. sp. and *C. bharmourensis* n. sp. in the present communication and have been described in detail. The three species possess similar maculation and wing pattern, but can be easily distinguished on the basis of genitalic features.

Cladarctia hansraji sp. nov.

(Figs 1, 4 to 10)

Head with vertex and frons covered with white scales, frons with some black scales on sides. Antenna with scape and flagellum studded with white scales, branches bearing black scales. Eyes golden brown with black spots. Labial palpus porrect, just reaching lower level of frons; segments decorated with black scales.

Thorax furnished with white scales; a dorsal median black fascia; collar clothed with white scales and bearing small black spots, edged with yellow; tegula black, edged with white scales. Forewing with ground colour white; costal edge black up to antemedial area; a broad black fascia along subcostal, median and submedian nervures, another fascia on median nervure dividing into streaks along veins Cu_2 and M_2; spots on Cu_1, M_3, M_1 and R_3; fringe white; underside with costal fascia; vein R_1 arising from well beyond three-fourths of cell; veins R_2-R_5 stalked from before upper angle cell; M_1 from upper angle; M_2 from above lower angle of cell; M_3 and Cu_1 from lower angle of cell; Cu_2 from well beyond middle of cell. Hindwing with ground colour white; $Sc+R_1$ arising well before middle of cell; Rs and M_1 stalked from upper angle of cell; M_2 from above lower angle of cell; M_3 and Cu_1 from lower angle of cell; Cu_2 from middle of cell. Legs clothed with black scales; fore coxa decorated with yellow and black scales; femora orange above, fore femur black below; outer tibial spurs more than half length of inner ones.

Abdomen dressed with yellow scales, bearing short, black, dorsal bands; lateral and sublateral spots black; under

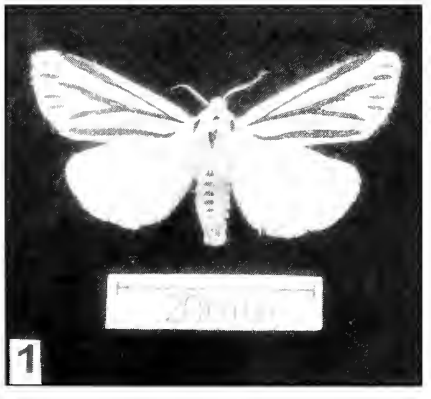


Fig. 1: *Cladarctia hansraji* sp. nov.

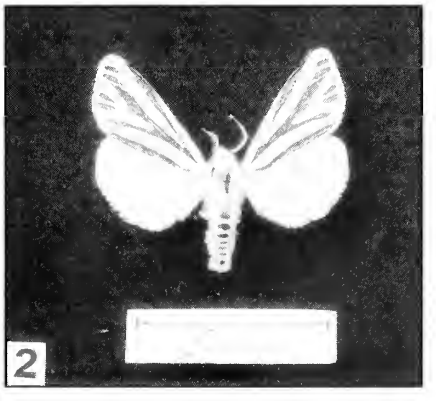


Fig. 2: *Cladarctia discocellulatus* sp. nov.

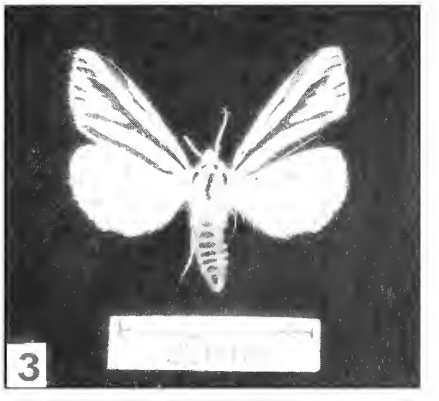
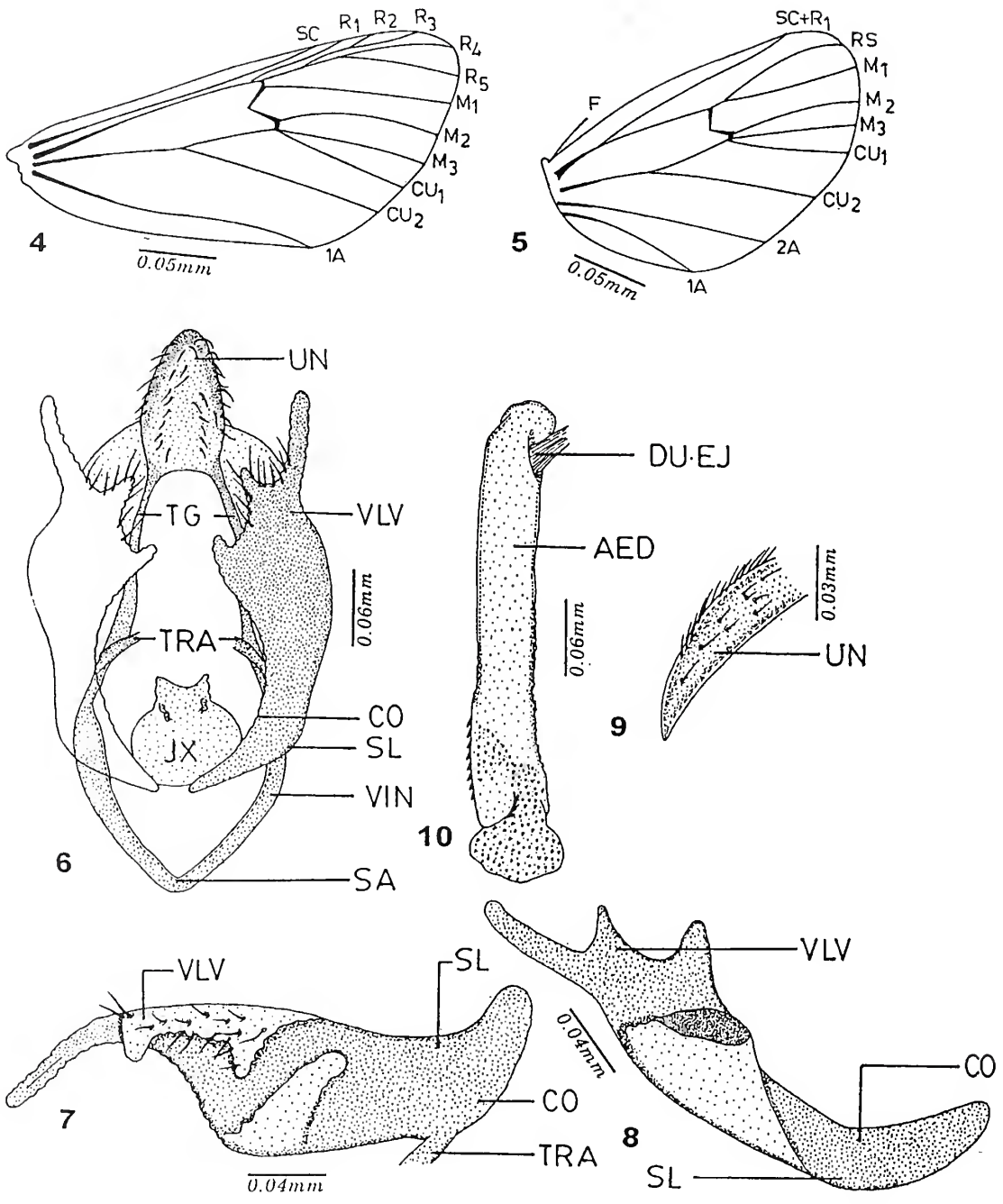


Fig. 3: *Cladarctia bharmourensis* sp. nov.



Figs 4-10: *Cladarctia hansraji* sp. nov., 4. Forewing, 5. Hindwing, 6. Male genitalia, 7. Valva (right) – inner view, 8. Valva (right) – ventrolateral view, 9. Uncus – lateral view, 10. Aedeagus

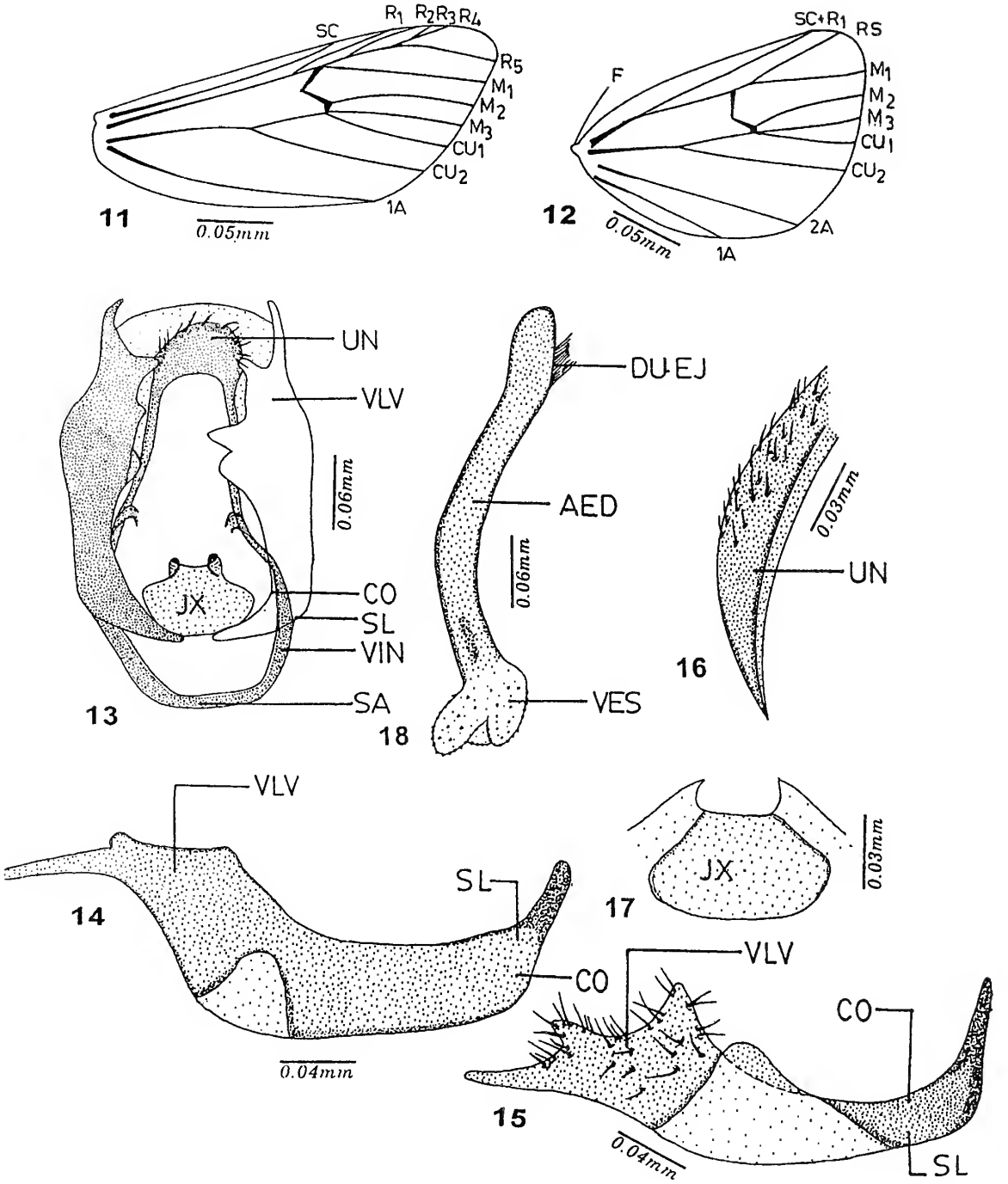
surface white. Male genitalia with uncus moderately long, triangular, narrowing towards tip, slightly curved near distal end, tip narrow and pointed, dorsally setosed; acrotergite covering lower half of uncus; tegument slightly longer than vinculum, with margins slightly corrugated; vinculum U-shaped; saccus developed. Valva long and narrow, costa well defined; apical portion with three district projections, costal margin bearing a large inwardly folded flap; juxta saucer-shaped, apical margin emarginated. Aedeagus long and slender, both of its walls heavily sclerotized, one of its walls bearing small spines beyond middle; a circular patch bearing three very minute spines at distal end. Female genitalia not examined.

Wing Expanse (Half): Male: 20 mm

Material Examined: Holotype: 1 male, Himachal Pradesh, Kalpa, 3,000 m, 2.vii.1995, Coll. A.P. Singh.

Paratype: 2 males, data as for Holotype.

Distribution: INDIA: Himachal Pradesh.



Figs 11-18: *Cladarctia discocellulatus* sp. nov., 11. Forewing, 12. Hindwing, 13. Male genitalia, 14. Valva (left) – inner view, 15. Valva (left) – ventrolateral view, 16. Uncus – lateral view, 17. Juxta-enlarged, 18. Aedeagus

Remarks: *Cladarctia hansraji* sp. nov. is closely related to *C. discocellulatus* sp. nov. on the basis of certain morphological characters like wing venation and absence of submarginal black spots on hindwing. However, it is distinct from *discocellulatus* in the absence of a prominent discoidal black spot on hindwing. The armature of the aedeagus also distinguishes it from *discocellulatus*.

Etymology: The species is named after an eminent Indian entomologist Prof. Hans Raj Pajni of Panjab University, Chandigarh.

Cladarctia discocellulatus sp. nov.

(Figs 2, 11 to 18)

Head with vertex and frons covered with white scales, frons with black patches on sides. Antenna with scape and flagellum studded with white scales, branches black. Eyes

golden with small black spots. Labial palpus porrect, just reaching lower level of frons; first segment decorated with yellow scales; second and third clothed with black scales.

Thorax clothed with white scales; a median black strip present; collar furnished with white, edged with yellow scales, spotted with black; tegula white, stripped with black. Forewing with ground colour white, costal edge black near apex; subcostal, median and submedian black fasciae; subcostal fascia broadening gradually towards apex; median fascia with streak on vein Cu_2 and extending to M_1; submarginal spots on veins Cu_1, M_2, M_3 and R_5; a black point-like spot on apex; fringe white; underside with costal fascia; veins R_2-R_5 stalked from upper angle of cell; M_2 from above lower angle; M_3 and Cu_1 from lower angle of cell; Cu_2 beyond three-fourths of cell. Hindwing with ground colour white; a prominent discoidal black spot present; fringe white; Sc + R_1 originating before middle of cell; Rs and M_1 stalked from upper angle of cell; M_2 from well above lower angle of cell. Legs clothed with black scales; fore coxa yellow, sides with fuscous scales; femora orange above, fore femur black below; mid and hind femora fringed with white scales; hind tibia and tarsi white, tarsi stripped with black; outer tibial spurs more than half length of inner ones.

Abdomen furnished with yellow scales, underside clothed with white scales; black bands on dorsal segments conspicuous, first and last segment bearing black spots instead of bands; lateral and sublateral series of black spots. Male genitalia with uncus moderately long, triangular, broad at base, narrow towards distal end, appearing pointed laterally; acrotergite well developed, rounded; tegumen with both of its walls strongly sclerotized, longer than vinculum; vinculum U-shaped; saccus not defined. Valva small and narrow; sacculus slightly developed; costa highly differentiated; apical portion with three projections, two small and one large; left valva with lower projection reduced, middle one longer than its counterpart on right valva; costal margin with large-flap like process; juxta broad at base, apical portion emarginated and membranous; transtilla bar-like. Aedeagus long, curved, anterior tip rounded, both of its walls equally sclerotized; vesica without any distinct armature. Female genitalia not examined.

Wing Expanse (Half): Male: 19 mm.

Material Examined: Holotype: 1 male, Uttar Pradesh, Kasauni, 2,000 m, 12.vi.1995, Coll. A.P. Singh.

Paratype: 1 male, Himachal Pradesh, Kalpa, 3,000 m, 2.vii.1995, Coll. A.P. Singh.

Distribution: INDIA: Uttar Pradesh, Himachal Pradesh.

Remarks: As already discussed *Cladarctia discocellulatus* sp. nov. is very closely allied to *C. hansraji* sp. nov. *C. discocellulatus* is also related to another new species *C. bharmourensis* as far as wing maculation, pattern and armature of aedeagus are concerned. But it is distinct and can be differentiated from *bharmourensis* on the basis of its unique male genitalic features.

Etymology: The species has been named on the basis of the prominent discoidal spot on the hindwing.

Cladarctia bharmourensis sp. nov.

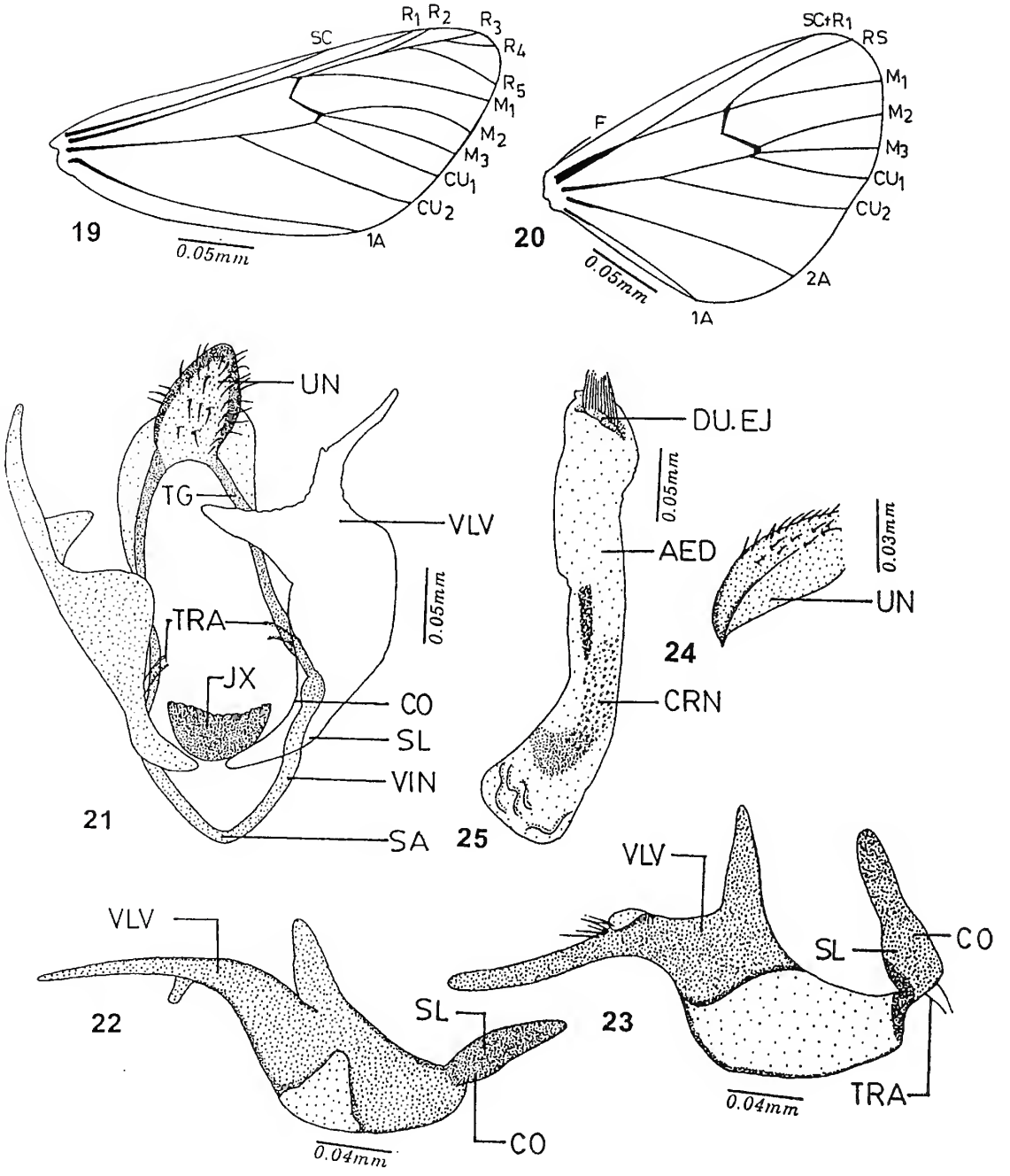
(Figs 3, 19 to 25)

Head with vertex and frons furnished with white scales, frons bearing black patches on sides. Antenna with scape and flagellum studded with white scales, branches black. Labial palpus porrect, reaching lower level of frons; first segment decorated with yellow scales, second and third segments clothed with black scales.

Thorax decorated with white scales, a dorsal median black fascia; collar covered with white scales, prominent black spots and edged with yellow; tegula white, stripped with black. Forewing with ground colour white, costa edged with black towards base; subcostal black fascia originating from before middle of wing, gradually broadening towards apex; median fascia from base to vein M_2, ending well before termen, sending streak to vein Cu_2; spots on veins Cu_1, M_3, M_1 and R_5; underside with costal fascia; veins R_2-M_1 stalked from upper angle of cell; M_2 and M_3 originating from lower angle of cell; Cu_2 from just beyond two-thirds of cell. Hindwing with ground colour white, discoidal black spot; submarginal spots on M_2, Cu_2 and 2A; fringe white; Sc + R_1 from middle of cell; Rs and M_1 arising from upper angle of cell; Cu_1 from before lower angle of cell; Cu_2 from well beyond middle of cell. Legs dressed with black scales; fore coxae yellow; fore femur orange above, black below; mid and hind femora fringed with white; hind tibia and tarsi white; tarsi banded with black; outer tibial spurs more than half the length of inner ones.

Abdomen covered with yellow scales, underside clothed with white scales; short dorsal segmental bands present; first and last segments with oblong spots; lateral and sublateral series of black spots. Male genitalia with uncus of moderate size, triangular, slightly swollen at base, narrow and pointed at tip, dorsally setose; acrotergite covering lower half of uncus; tegumen longer than vinculum; vinculum V-shaped; saccus defined. Valva short and broad, narrow at both ends; costa well developed; apical portion with two unequal finger-like projections; saccular margin with a flap-like projection on left valva, same is produced into finger-like projection in right valva; costal margin with flap-like projection; juxta well sclerotized, cup-shaped. Aedeagus of moderate size, narrow and slender; vesica without any armature. Female genitalia not examined.

Wing Expanse (Half): Male: 21 mm.



Figs 19-25: *Cladarctia bharmourensis* sp. nov., 19. Forewing, 20. Hindwing, 21. Male genitalia, 22. Valva (left) – inner view, 23. Valva (left) ventrolateral view, 24. Uncus – lateral view, 25. Aedeagus

Material Examined: Holotype: 1 male, Himachal Pradesh, Bharmour, 2,000 m, 15.vi.1993, Coll. A.P. Singh.

Paratype: 2 males, data as for Holotype.

Distribution: INDIA: Himachal Pradesh.

Remarks: As many as three representatives of *C. bharmourensis* sp. nov. were collected from a single locality of Himachal Pradesh. It is related to *C. discocellulatus* sp. nov. as described earlier.

Etymology: The species is named after its type locality Bharmour town in Chamba district, Himachal Pradesh.

KEY TO THE INDIAN SPECIES OF *CLADARCTIA* KODA

1. Forewing with vein Cu_1, arising from lower angle of cell; hindwing without submarginal spots; valva of male genitalia with apical portion bearing three prominent projections ... 2

— Forewing with Cu_1, originating from before lower angle of cell; hindwing with black submarginal spots; valva of male genitalia having more or less than three, apical projections 3

2. Tegula black, edged with white scales, hindwing without discoidal spot; aedeagus with one of its walls bearing small spines beyond middle; sclerotized patch having three distinct spines at distal end ..... *hansraji* n. sp.

— Tegula white, stripped with black scales; hindwing with a black discoidal spot; aedeagus with both walls without spines; no distinct armature at distal end ..... *discocellulatus* n. sp.

3. Forewing with veins R_2-R_5 stalked from upper angle of cell; M_1 from upper angle; hindwing with four submarginal black spots ..... *quadriramosa* (Kollar)

— Forewing with veins R_2-M_1 stalked from upper angle; hindwing with three submarginal black spots ..... *bharmourensis* n. sp.

Abbreviations used

1A: First anal vein, 2A: Second anal vein, AED: Aedeagus, CO: Costa, CRN: Cornuti, Cu_1: First Cubital Vein, Cu_2: Second Cubital Vein, F: Frenulum, JX: Juxta, M_1: First median vein, M_2: Second median vein, M_3: Third median vein, R_1: First radial vein, R_2: Second radial vein, R_3: Third radial vein, R_4: Fourth radial vein, R_5: Fifth radial vein, Rs: Radial sector, SA: Saccus, Sc: Subcosta, $Sc+R_1$: Stalk of $Sc+R_1$, SL: Sacculus, TG: Tegumen, TRA: Transtilla, UN: Uncus, VES: Vesica, VIN: Vinculum, VLV: Valva.

ACKNOWLEDGEMENTS

I thank Dr. N. Koda of Japan for valuable reprints and guidance. Financial Assistance rendered by CSIR, New Delhi is gratefully acknowledged.

REFERENCES

Hampson, G.F. (1894): Fauna of British India, Moths, including Ceylon and Burma 2: 1-609. Taylor and Francis Ltd., London.

Hampson, G.F. (1901): Catalogue of Lepidoptera Phalaenae in the British Museum 3: 1-690.

Koda, Nobutoyo (1988): A generic classification of the subfamily Arctiinae of Palaearctic and Oriental regions based on male and female genitalia (Lepidoptera: Arctiidae), Part-II. *Tyo to Ga 38(3)*: 1-79.

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FISHES OF THE GENUS *NEMACHEILUS* (BLEEKER 1863) IN KERALA WITH DESCRIPTION OF A NEW SPECIES, *NEMACHEILUS PERIYARENSIS*[1]

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Fishes of the genus *Nemacheilus* (Bleeker 1863) are represented by 10 species in Kerala. During fish species inventory surveys carried out in Periyar lake, three specimens of this genus collected were different in morpho-meristic characters and colour pattern from the species hitherto described. The new species is named *Nemacheilus periyarensis* after the water body from which it was collected. A key to the species of genus *Nemacheilus* reported from Kerala is given with a detailed description of the new species.

Key words: *Nemacheilus periyarensis* sp. nov., Periyar lake, Kerala

INTRODUCTION

The genus *Nemacheilus* (Bleeker) consists of a group of species that are remarkably similar in general morphology. Since they lack the spines, scutes, various other processes, and features of taxonomical value, species under *Nemacheilus* (Bleeker) are the most difficult to distinguish and differentiate (Menon 1987). Nemacheiline species from India were described first by Hamilton-Buchanan (1822). Subsequently, McClelland (1839); Günther (1868); Day (1878); Hora (1935) and Menon (1987) described a number of new species. No attempt has so far been made to revise the Nemacheilinae species inhabiting Indian waters, barring the partial revision of the genus from Eastern Himalayas and the revision of the Cobitoid fishes by Menon (1987). More than 450 species have been described under the subfamily Nemacheilinae (Kottelat 1990). These are distributed in South China, Southeast Asia, Baluchistan, Western Iran and Northeast Africa. Seventy-nine Nemacheiline species under 2 genera, *Nemacheilus* and *Triplophysea* are known from the Indian waters (Menon 1987). Nine subgenera under *Nemacheilus* and ten subgenera under *Triplophysea* have so far been described. Genus *Nemacheilus* includes the subgenera *Schistura* McClelland, *Acanthocobitis* Peters, *Nemacheilus* Van Hesselt, *Nemachilicthys* Day, *Mesonemacheilus* Benarescu and Nalbant, *Infundibulatus* subgenera nov; *Petruichthys* subgenera nov; *Aborichthys* Chaudhuri and *Indoreonectes* Rita and Benarescu. In *Schistura*, 11 species have been recognized, while the subgenus *Petruichthys* and *Nemachilicthys* have only one species each, *Nemacheilus brevis* and *Nemacheilus ruppelli* respectively. Ten species have so far been described under the genus *Nemacheilus* in Kerala waters. (Jayaram 1999) and a few species described earlier have been treated as synonyms of these 10 species (Menon 1999). While investigating the fish fauna of Periyar lake, one of the 18 biodiversity hot spots of India, the authors came across three specimens whose morpho-meristic features and colouration were found to be totally different from those of the species hitherto described. A new species has therefore been erected whose description is given below. A number of species have been reported from Periyar lake by Raj (1941); Hora (1941); Menon and Jacob (1996); Zacharias and Minimol (1999) and Gopi (2001). A key to the species recorded under the genus *Nemacheilus* in Kerala is also given.

MATERIAL AND METHODS

The type locality of the new species is Thannikkudy, Periyar Lake, Kerala, south India between 9° 28' 91" N and 77° 16' 44" E. Morphometric measurements were recorded with dial callipers to the nearest millimetre and expressed as percent of standard length. Meristics were counted following Talwar and Jhingran (1991).

Nemacheilus periyarensis sp. nov. (Fig. 1)

Holotype: Deposited in ZSI Calicut, No. ZSI (WGRS) CLT.V/F 13030. 85.2 mm TL, Periyar Lake, 18.ii.2002.

Paratypes: 2 ex. Deposited in School of Industrial Fisheries Museum. 80.6-82.0 mm TL, Periyar Lake, 18.ii.2002.

Diagnosis: An elongated and slender species, dorsal fin with 9 branched rays, lateral line incomplete, ends above the anal fin, body with irregular network of bands and blotches, dorsal and caudal fins with 4 or more rows of dark bands and a black ocellus at the lower angle of the caudal peduncle, very near to the caudal origin.

Description: Based on 3 specimens collected from Thannikkudy, Periyar lake, ranging from 67.38 to 69.58 mm SL.

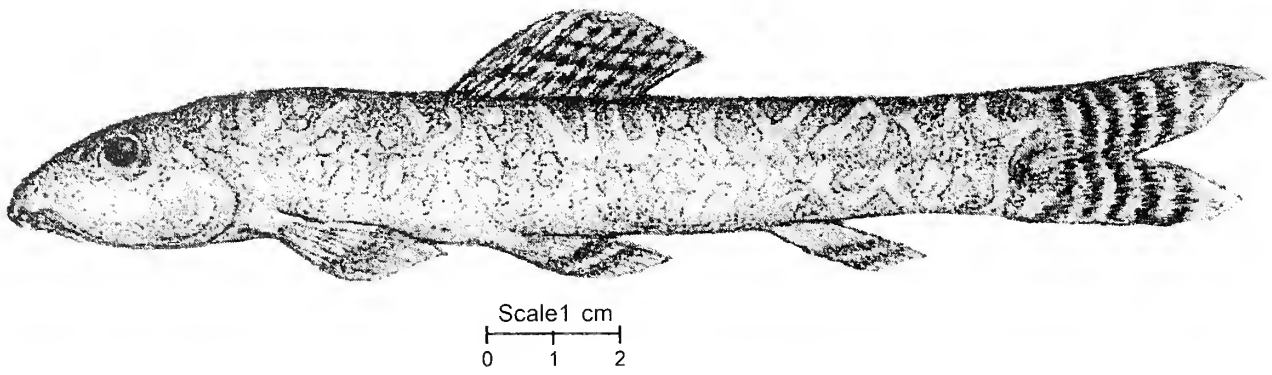

Fig. 1: *Nemacheilus periyarensis* sp. nov.

DI, 9; PI, 9; VI, 6; AI, 5; C19.

Dorsal profile slightly arched, compared to the ventral. Lateral line ending above the anal origin. Eyes moderately large, nostrils close to each other, head longer than broad, mouth more or less semicircular, subterminal with the upper jaw slightly prolonged. Barbels well developed, 3 pairs, depth of the body 12.5-13.69% (13.059) in SL, length of the head 17.73-22.87% (20.3) of SL, snout length less than interorbital width, the latter less than the postorbital length. Eyes not visible from ventral side of the head, diameter 19.88-26.33% (23.10) of head length, shorter than the interorbital width, 38.4-72.5% (55.45) of the latter. Anterior nostrils flap-like. Mouth slightly pointed rather than semicircular, lips fleshy, lower lip interrupted in the middle. Barbels well developed, broader at their bases and with pointed tips, outer rostral barbels longer than inner ones and are equal to or larger than the maxillary barbels, not extending to the anterior border of eye. Caudal peduncle length 10.34-13.56% (11.95) in SL, least depth 65.23-79.83% (72.53) in head length. (Mean value in parentheses)

Squamation: Lateral line incomplete, ending above the origin of the anal fin or slightly behind it, and followed by a shallow groove, which becomes deeper as it reaches the caudal peduncle. Scales small, imbricate, covering the whole body except ventral profile between pectoral and pelvic fins.

Fins: Dorsal fin inserted closer to snout than to caudal. Its base larger, forming 63.97-84.74% of the height. Height 89.18% in head length. Pectorals smaller than head length, 83.72% in head length. Pelvic fins smaller than head and pectoral fins, length 70.92% in head length and 77.77% in pectoral fin length. Ventral not reaching anal fins and the latter not reaching the caudal fin. Distance between pectoral and ventral is 26.32% in SL. Distance between ventral and anal fins 24.57-30.2% in SL. Pre-anal distance 70.11%-78.6% in SL, pre-dorsal distance smaller, 43-48% in SL. Pre-ventral distance 4.59%-5.01% in SL, pre-pectoral distance 19.49-25.20% in SL. Caudal forked.

Colouration: Ground colour light brown with irregularly descending narrow yellow bands, which sometimes coalesce to form reticular networks. Irregular yellow spots or bands dispersed between them. Bands also arise from the ventral side towards the lateral line. The pattern of colouration extends on to the head and snout region. Dorsal fin marked with 4 dark bands, while caudal fin has 5 narrow dark bands. Bands are also seen on the paired fins. Pectoral fins are either with dusky rays or with well-distinguished dark band. Ventral fins have two narrow dark coloured bands. Anal fin also with two dark narrow bands. Dark ocellus at the lower angle of the caudal peduncle, close to the origin of caudal rays.

Distribution: Thannikkudy in Periyar lake, Kerala, South India.

Etymology: Named after the water body from where the specimens were collected.

Remarks: The new species, *Nemacheilus periyarensis* shows close resemblance to *Nemacheilus pulchellus* (Day) reported from North India in its colouration and body characteristics. However, the new species can easily be distinguished from *Nemacheilus pulchellus* by the presence of 9 branched rays on the dorsal fin against 10 branched rays reported in the latter. Further, unlike in *N. pulchellus*, only the lower lip is interrupted in the middle and the lateral line is not complete in the new species. The new species also shows similarity with *Nemacheilus petrubanarescui* (Menon 1984) in colour pattern and ratio of body depth to standard length. However, the dorsal fin is not inserted equidistantly between the snout and caudal fin in *Nemacheilus periyarensis*. Also, in the former, the dorsal fin has only 8 rays. The new species described is compared with closely related species, the results are given in Table 1.

Table 1: Comparison of *Nemacheilus periyarensis* sp. nov. with closely related species

Character	*N. periyarensis*	*N. pulchellus*	*N. guentheri*	*N. petrubanarescui*	*N. triangularis*
No. of rays on the dorsal fin	9	10	8	8	8
Insertion of dorsal fin	Closer to the snout than to the caudal	Equidistant or slightly closer to the snout	Equidistant between the snout and caudal fin	Equidistant between the snout and caudal fin	Equidistant between the snout and caudal fin
No. of barbels	3 pairs	3 pairs	3 pairs	3 pairs	3 pairs
Colour pattern on body	Bands descending from dorsal to ventral side, oblique, forming network. Yellow oblique spots dispersed	Yellow spots and bands between the vertical bands	2-3 rows of yellow spots on the body, black edged	7-8 saddle shaped bands which are anteriorly broken into a number of narrow bands	Varies considerably with age. Yellow 'Y'-shaped bands
Bands on fins	4 rows of bands on dorsal, 5 rows on caudal, 2 rows on ventral and anal, single on pectoral	Dorsal fin with two dark bands	3-4 rows of spots on dorsal	A row of spots on dorsal, two dark bands on caudal	Dorsal and caudal with two bands each, anal and pelvic fins with one each
Placement of vent	Closer to the anal fin; and the distance between the anal fin origin to the anal opening forms 18.78% in the distance between the ventral fin origin and anal fin origin	Closer to the anal and the distance between the anal fin origin to the anal opening forms 16.17% in the distance between the ventral fin origin and anal fin origin	Closer to the anal and the distance between the anal fin origin to the anal opening forms 18.55% in the distance between the ventral fin origin and anal fin origin	Closer to the anal and the distance between the anal fin origin to the anal opening forms 29.8% in the distance between the ventral fin origin and anal fin origin	Closer to the anal and the distance between the anal fin origin to the anal opening forms 23.66% in the distance between the ventral fin origin and anal fin origin
Lateral line	Incomplete, ending at the origin of anal fin	Complete	Incomplete, ending above the anal fin	Incomplete, ending at the base of anal fin	Complete

KEY TO THE SPECIES OF *NEMACHEILUS* (BLEEKER 1863) REPORTED FROM FRESHWATERS OF KERALA

1. Pair of well developed nasal barbels 2
— No well developed nasal barbels 3
2. Body marked with well-defined and regular cross bars ..... *Nemacheilus evezardi*
— Body marked with narrow, small bars that are irregularly dispersed ..... *Nemacheilus keralensis*
3. Body marked by series of vertical bars 4
— Body not marked with a series of vertical bars 5
4. Caudal emarginate, lateral line ending in front of dorsal fin ..... *Nemacheilus denisonii*
— Caudal forked, lateral line complete, body with vertical bars and black spots ..... *Nemacheilus semiarmatus*
5. Body with moniliform black lateral band, seven branched rays on dorsal fin ..... *Nemacheilus monilis*
— Body marked with irregular net of dark brownish and whitish yellow bars, a medium sized small dark bar at base of caudal fin 6
6. Dorsal fin with 9 branched rays, lateral line incomplete ..... *Nemacheilus periyarensis*
— Dorsal fin with 8 branched rays, lateral line complete or incomplete 7
7. Body marked with 2 or 3 rows of large yellow spots edged with black, lateral line incomplete ... *Nemacheilus guentheri*
— Body with oblique bands 8
8. Body with Y-shaped bands ..... *Nemacheilus triangularis*
— Body with varying number of wavy bands which sometimes coalesce to form reticulate networks 9
9. Saddle-shaped 7-8 black bands, sides with varying number of bands, broken up into narrow bands anteriorly ..... *Nemacheilus petrubanarescui*
— Body with irregular dark blotches on back, sides with reticulation of dark blotches and wavy bands ..... *Nemacheilus menonii*

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Dr. K. Rema Devi and Dr. T.J. Indra for their sincere effort in separating the new species from our collection of loaches examined by them. The financial support given by the NAT-ICAR Project for the present study is thankfully acknowledged. Thanks are also due to Prof. (Dr.) C. Hridayanathan, Director, School of Industrial Fisheries, for providing necessary facilities for carrying out this study. Deep gratitude is also extended to C.P. Sunil Kumar and M.D. Mahesan who assisted the team for the survey.

REFERENCES

DAY (1878): Fishes of India being a natural history of fishes known to inhabit the sea and fresh waters of India, Burma and Ceylon. Dawson, London 1:778: 2: 195 plates (Reprint 1958).

GOPI, K.C. (2001): *Garra periyarensis*, a new cyprinid fish from Periyar Tiger Reserve, Kerala, India. *J. Bombay Nat. Hist. Soc. 98*: 92-83.

GUNTHER, A. (1868): Catalogue of the fishes of the British Museum, London. 7, xx+512.

HAMILTON-BUCHANAN, F. (1822): An account of the fishes found in the river Ganges and its branches I-VII, Archibald, Edinburgh Hurst, Robinson & Co, London. 1-405, pls. 1-39.

HORA, S.L. (1935): On a collection of fish from Afghanistan. *J. Bombay Nat. Hist. Soc 37*: 784-802.

HORA, S.L. (1941): Homalopterid fishes from Peninsular India. *Rec. Indian. Mus. 43*: 230-231.

JAYARAM, K.C. (1999): The freshwater fishes of the Indian region. Narendra Publishing House, New Delhi. 509 pp.

KOTTELAT, M. (1990): Indochinese nemacheilines: a revision of Nemacheiline loaches (Pisces: Cypriniformes) of Thailand, Burma, Cambodia and Southern Vietnam *Verl F. Pfeil: Munchen,* pp. 1-262.

MCCLELLAND, J. (1839): Indian Cyprinidae. *Asiat. Res. 19*: 217-471, pls. 37-61.

MENON, A.G.K. (1984): *Nemacheilus (Mesonemacheilus) petrubanarescui*, a new loach from Dharmasthala, Karnataka state, India (Pisces, Cobitidae). *Cybium 8(2)*: pp. 45-49.

MENON, A.G.K. (1987): The Fauna of India and adjacent countries. *Rec. zool. Surv. India* Vol. IV, pp. 1-259.

MENON, A.G.K. (1999): Checklist of freshwater fishes of India. *Rec. zool. Surv. India, Occ. paper No. 175*: 1-366.

MENON, A.G.K. & P.C. JACOB (1996): *Crossocheilus periyarensis*, a new cyprinid fish from Thannikkudy (Thekkadi), Kerala, India. *J. Bombay Nat. Hist. Soc. 93(1)*: 62-64.

RAJ, B.S. (1941): A new genus of Schizothoracinae fishes from Travancore, South India. *Rec. Indian Mus. 43*: 209-214.

TALWAR, P.K. & A.G. JHINGRAN (1991): Inland fishes of India and adjacent countries. Oxford and IBH Publishing Co., New Delhi. 2 volumes: xix + 1158.

ZACHARIAS, V.J. & K.C. MINIMOL (1999): *Nemacheilus menonii* a new species of fish from Malappara, Periyar Tiger Reserve, Kerala. *J. Bombay Nat. Hist. Soc. 96(2)*: 288-290.

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A NEW NEMACHEILINE FISH OF THE GENUS *SCHISTURA* McCLELLAND (CYPRINIFORMES: BALITORIDAE) FROM MANIPUR, INDIA[1]

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A new nemacheiline fish species, *Schistura tigrinum* is described here from the Barak river (Brahmaputra drainage) of Manipur, India. The species is characterised by 18-30 dark brown transverse bars on the body, irregularly arranged, often fused at different points, width of each equals pale white interspaces, moderately high adipose crest on dorsal and ventral sides of caudal peduncle, a long head (26.1-27.9% of standard length), dorsal fin with 8½ branched rays and an incomplete lateral line.

Key words: new nemacheiline fish, genus *Schistura*, Manipur

INTRODUCTION

Manipur state, in the extreme northeastern part of India, has numerous hill streams with a rich loach fauna. New species of the genus *Schistura* McClelland were described by Chaudhuri (1912), Hora (1921), and Tilak and Hussain (1990) from Manipur. Hora (1937) also reported the occurrence of *S. vinciguerrae* in the Namya river of the State. Vishwanath (2000) and Vishwanath and Laisram (2001) reported the occurrence of eight species of *Schistura* in the State.

The Barak river originating from Lai Leiyai area of the Senapati district of Manipur takes a southern course into the hilly terrain of the Tamenglong district, and then into Churachandpur district and Jiribam subdivision (Imphal district) to finally flow out of the State at Jirighat. The river forms a part of the Brahmaputra drainage. While making fish collections from the Khunphung area of Tamenglong district, seven specimens of *Schistura* which do not fit into the descriptions of any known species of this genus have been found. This species is described here as *Schistura tigrinum* sp. nov. Counts and measurements follow Kottelat (1990). Type specimens of the species are deposited in the Manipur University Museum of Fisheries (MUMF), Imphal, Manipur.

Schistura tigrinum sp. nov.

Material examined: Holotype: MUMF 4105, Female, 84.5 mm SL, Barak river at Khunphung, Tamei Subdivision, Tamenglong district, Manipur, 20.xi.1999, Coll. K. Nebeshwar Sharma.

Paratype: MUMF 4106/7; 3 specimens, male, 83.0-84.0 mm SL; 4 specimens, female, 86.0-97.0 mm SL. Collection data same as Holotype.

Diagnosis: A species of *Schistura* with the following combination of characters: 18-30 dark brown transverse bars on body, irregularly arranged, often fused at different points, width of each equals pale white interspaces, moderately high adipose crest on dorsal and ventral sides of caudal peduncle; long head (26.1-27.9% of SL), dorsal fin with 8½ branched rays; incomplete lateral line; strong processus dentiformes.

Description: D. iii, 8½; A. iii, 5½; C. 9+8; P.i, 10; V.i, 6. Body size large and elongate, depth increasing up to about halfway between tip of snout and caudal fin origin, almost uniform depth behind. Body section circular anteriorly, slightly compressed posteriorly. Head slightly depressed and elongate, cheeks inflated. Caudal peduncle tapered posteriorly. Moderately high adipose crest on dorsal aspect of caudal peduncle, extending up to middle of caudal fin. Pectoral fin extends up to half the length of the distance between pectoral and pelvic fin origins. Axillary pelvic lobe present; pelvic fin origin slightly behind dorsal fin origin, opposite 1st branched dorsal ray. Caudal fin deeply emarginate.

Body covered by embedded non-overlapping scales. Lateral line incomplete, extends to the level of vent or up to anal fin origin. Cephalic lateral line system with 7 supraorbital, 11+4 infraorbital, 9 operculo-mandibular and 3 supratemporal pores.

Anterior nostril pierced on the front side of a pointed flap-like tube with a very deeply notched anterior rim. Mouth arched, twice as wide as long. Upper lip with a small shallow median incision, lower lip with a deep one. Lips thick, with numerous uniform fine furrows, furrowed lobes of the lower lip slightly bigger. Strong processus dentiformes present. Inner rostral barbel reaches corner of mouth, and the outer one reaches a point vertical to the anterior margin of eye. Maxillary barbel extends beyond a point vertical to posterior rim of eye. Head longer than depth of body, its width more than half of its lateral length. Eyes moderate, situated dorsally, completely invisible from ventral side. Mouth gape wide. Tip of snout and barbels covered with minute pointed tubercles.

Sexual dimorphism: Suborbital flap absent in males. Males smaller and shorter, having fewer coloured vertical bars.

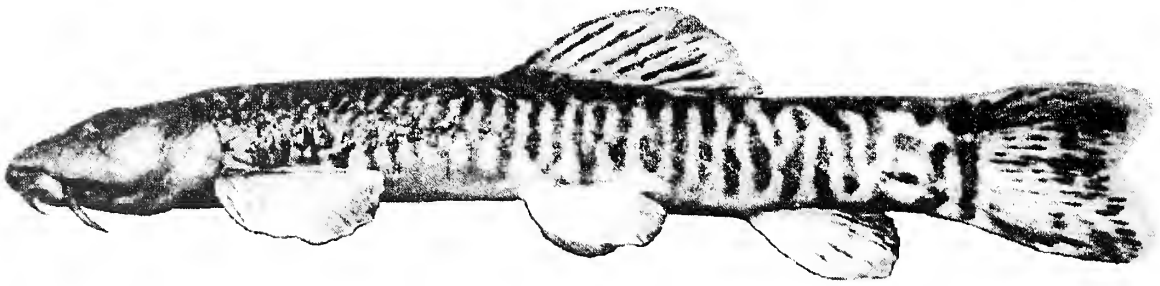

Fig. 1: *Schistura tigrinum* sp. nov. (lateral view)

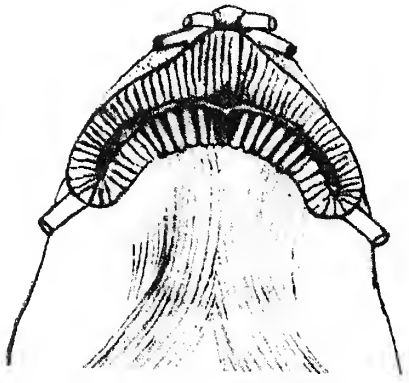

Fig. 2: Ventral view of head of *S. tigrinum* (showing structure of lips)

Table 1: Comparison of characters of *S. tigrinum, S. vinciguerrae* and *S. poculi*

Sl.	*Schistura tigrinum*	*Schistura vinciguerrae*	*Schistura poculi*
1.	17-30 dark brown colour bars, no blotch on back and lateral side. Bars in front of dorsal fin slightly thinner.	10-16 dark bars, 2-3 dark saddles in front of dorsal fin and 4-5 bars behind dorsal fin and the bars on each side also meet along the dorsal midline. Bars in front of dorsal fin conspicuously thinner than those behind.	15-17 dark brown bars, 11-12 dark blotches on the back. Bars conspicuously thinner than those behind dorsal fin.
2.	Bars reach ventral midline on caudal peduncle but not meeting their homologues.	Bars reach ventral midline on caudal peduncle, meet their homologues.	
3.	Dorsal fin with no black blotch at base of simple and branched rays. Dorsal fin rays stained black.	Dorsal fin with a black blotch at base of last simple and first branched ray and a second blotch behind.	Dorsal fin with a black blotch at base of last simple and first branched ray and a second blotch behind.
4.	Pelvic fin does not reach anal fin origin.	Pelvic fin reaches anus or slightly beyond the anus	Pelvic fin reaches about halfway to anal fin.
5.	Moderately high dorsal and ventral crest on caudal peduncle.	No crest on caudal peduncle	No crest on caudal peduncle.
6.	Anterior nostril pierced in front of a pointed flap-like tube with very deep notch at anterior rim.	Anterior nostril pierced in front side of a pointed flap-like tube. No notch at anterior rim.	Slightly pointed flap-like tube. No notch at anterior rim.
7.	Lips very thick, a wide median incision and a small incision on upper lip and uniformly spaced furrows on the whole area of both lips	Lips not very thick, lower lip with a median interruption and 3-5 deep furrows in the median area on each side.	Lips not very thick, lower lip with a wide incision, knob-like structure on either side of the incision, rest of it plain.

Table 2: Comparative morphometry of *Schistura tigrinum*, *S. vinciguerrae* and *S. poculi*

	Schistura tigrinum		*Schistura vinciguerrae*		*Schistura poculi*	
	In % of SL	In % of HL	In % of SL	In % of HL	In % of SL	In % of HL
	Mean (Range) ±SD	Mean (Range) ±SD	Mean (Range) ±SD	Mean (Range) ±SD	Mean (Range) ±SD	Mean (Range) ±SD
Lateral head length	26.6(26.1-27.9) ±0.9		20.3(18.3-21.3) ±0.87		22.6(20.7-23.9) ±0.8	109.0(102.0-115.0) ±3.1
Dorsal head length	23.0(22.2-23.9) ±0.7		19.5(18.0-20.3) ±0.8		20.7(18.9-22.0) ±0.7	
Pre-dorsal length	53.0(52.5-53.8) ±0.6		51.4(48.9-52.6) ±1.1		53.0(49.9-55.2) ±1.1	
Pre- pelvic length	52.6(51.3-54.5) ±1.4		51.5(49.7-52.6) ±1.0		52.0(50.3-54.0) ±1.0	
Pre-anus length	74.1(72.8-75.0) ±1.0		68.8(66.8-71.3) ±0.3		70.8(68.7-73.5) ±1.2	
Pre-anal length	79.4(78.3-80.5) ±1.1		76.1(74.1-77.7) ±1.0		77.0(75.3-79.1) ±1.1	
Head depth (at eye)	11.9(10.9-13.0) ±0.9	51.8(49.3-54.5) ±2.2	9.9(8.9-10.7) ±0.5	51.0(47.0-54.0) ±1.7	10.3(9.5-11.6) ±0.6	50.0(46.0-55.0) ±2.3
Head depth (at nape)	12.5(11.9-13.3) ±0.6	54.3(53.5-55.4) ±0.9	11.9(10.7-13.0) ±0.6	61.0(57.0-65.0) ±2.5	12.0(10.8-13.6) ±0.7	58.0(54.0-65.0) ±2.8
Body depth	15.3(14.4-15.9) ±0.7	67.1(64.4-68.8) ±1.9	18.4(16.1-21.3) ±1.7	95.0(81.0-117.0) ±11.5	16.5(14.5-20.2) ±1.6	80.0(70.0-99.0) ±8.2
Caudal peduncle height	13.2(12.6-13.6) ±0.4	57.4(56.7-58.2) ±0.7	12.2(11.6-12.6) ±0.4	62.0(58.0-66.0) ±2.6	11.4(10.1-12.9) ±0.7	55.0(49.0-64.0) ±3.4
Caudal peduncle length	13.1(12.4-13.3) ±0.4	56.8(52.0-60.0) ±3.4	15.6(14.6-16.2) ±0.5	80.0(75.0-87.0) ±4.0	15.3(12.5-17.0) ±1.0	74.0(60.0-90.0) ±6.0
Snout length	12.9(12.4-13.6) ±0.5	56.2(55.7-56.9) ±0.5	8.9(8.2-9.7) ±0.4	46.0(43.0-48.0) ±1.6	9.5(7.9-11.4) ±0.8	46.0(39.0-53.0) ±3.2
Head width (at nares)	13.8(13.1-14.7) ±0.7	59.8(58.2-61.4) ±1.4	9.4(8.2-10.1) ±0.5	48.0(41.0-51.0) ±2.9	9.7(8.3-11.1) ±0.6	47.0(42.0-52.0) ±2.5
Max. head width at cheek	18.8(17.7-19.8) ±1.2	78.3(74.6-81.8) ±3.2	14.1(13.1-14.9) ±0.5	72.0(68.0-79.0) ±3.9	14.8(13.2-15.8) ±0.7	72.0(65.0-76.0) ±2.6
Body width (at dorsal fin origin)	13.0(12.6-13.5) ±0.4	56.6(53.5-58.3) ±2.1	13.7(12.3-15.3) ±1.0	70.0(61.0-82.0) ±6.8	12.2(10.6-14.1) ±1.0	59.0(49.0-69.0) ±5.2
Body width at anal fin origin	8.43(8.0-8.8) ±0.4	36.7(34.7-38.0) ±1.5	8.7(7.6-9.7) ±0.7	45.0(38.0-50.0) ±3.5	7.3(6.4-8.2) ±0.5	36.0(30.0-43.0) ±3.0
Eye diameter	3.4(3.3-3.6) ±0.1	14.7(14.0-15.1) ±0.5	4.0(3.2-4.5) ±0.4	20.0(17.0-22.0) ±1.5	3.8(3.0-4.8) ±0.4	18.0(14.0-22.0) ±2.1
Inter-orbital width	6.7(6.2-6.9) ±0.4	29.2(27.1-30.3) ±1.1	7.0(6.3-7.9) ±0.4	36.0(33.0-39.0) ±1.6	6.5(5.8-7.9) ±0.5	32.0(28.0-39.0) ±2.5
Dorsal fin height	14.2(13.9-14.7) ±0.3	61.5(59.4-63.3) ±1.8	15.2(13.2-16.6) ±1.1	78.0(70.0-85.0) ±4.7	14.1(09.6-18.3) ±1.9	68.0(47.0-88.0) ±9.2
Length of upper caudal lobe	22.8(21.1-24.1) ±1.3	98.9(95.3-104.2) ±3.9	21.8(20.6-23.1) ±0.7	111.0(105.0-117.0) ±4.1	21.3(18.8-23.4) ±1.0	103.0(88.0-116.0) ±5.5
Length of lower caudal lobe	23.4(22.3-24.9) ±1.2	101.8(99.5-107.8) ±4.0	23.4(19.9-25.3) ±1.4	120.0(106.0-128.0) ±7.2	22.2(20.5-25.2) ±1.1	107.0(99.0-124.0) ±6.3
Length of median caudal rays	17 4(17.2-17.6) ±0.2	75.8(71.8-78.1) ±2.8	16.7(14.7-18.1) ±1.2	86.0(77.0-100.0) ±7.5	15.3(12.5-18.6) ±1.6	74.0(60.0-93.0) ±8.8
Depth of anal fin	16.7(16.3-17.3) ±0.4	72.7(69.3-75.0) ±2.4	17.6(16.1-19.8) ±1.0	90.0(85.0-99.0) ±3.6	17.1(15.4-19.2) ±1.1	83.0(71.0-94.0) ±6.0
Pelvic fin length	16.8(16.2-17.8) ±0.5	73.2(71.3-75.5) ±1.7	18.7(16.9-20.7) ±1.0	96.0(89.0-102.0) ±4.8	17.3(15.7-18.6) ±0.7	84.0(77.0-91.0) ±3.7
Pectoral fin length	19.4(18.4-20.5) ±1.0	84.0(80.6-88 5) ±3.3	22.3(19.6-24.2) ±1.3	115.0(104.0-122.0) ±5.6	19.5(18.0-21.2) ±1.0	94.0(86.0 -103.0) ±4.2

Colour: Body olivaceous grey with 18-30 dark brown vertical bars. There is great variation in the colour pattern and number of bars. The width of the bars increases from head to caudal fin base, bars as wide as the interspaces. There is gradual increase in the number of bars with increase in length. There are 29-30 vertical bars in the larger specimens (88.0-97.0 mm SL). Some bars behind the dorsal fin are regularly arranged. Most of the bars in front of the dorsal fin are divided vertically into two or three, united dorsally. Most of the vertical bars posterior to dorsal fin split into two halves, some such splits form incomplete bars. All the bars have dark edges.

In smaller specimens (83.0-84.5 mm SL), there are 17-18 bars. Some bars on the pre-dorsal area are reticulated. A distinct, vertically elongated spot on lower half of caudal base and a comparatively small spot on its upper extremity. All the bases of the simple and branched rays are black, except for a small gap between simple and first branched ray. Anal and pectoral fins have a few black rays. Dorsal surface of head and nape have reticulated bars. Last simple and all branched dorsal rays have a row of elongated black marks. Caudal fin has 3-4 irregular vertical rows of spots.

Etymology: The fish has been named after the tiger-like striations on the body.

Distribution and Habitat: Known only from the type locality, Barak River at Khunphung, Tamenglong district, Manipur. The fish inhabits the pebbly bottom of large, swift flowing streams.

Discussion: There is wide variation in the colour pattern and number of colour bars, i.e. 17-30 bars. The new species is very close to *S. vinciguerrae* (Hora) and *S. poculi* (Smith) in colour pattern. But it can be distinguished by its moderately high dorsal and a small ventral crest on the caudal peduncle (absent in both *S. vinciguerrae* and *S. poculi*), anteriorly tapered shape of caudal peduncle profile and 3-4 irregular vertical coloured bands on caudal fin; longer head (26.1-27.9 vs. 18.3-21.3 and 20.7-23.9); longer head width at nares (13.1-14.7 vs. 8.2-10.1 and 8.3-11.1); wider head (17.7-19.8 vs. 13.1-14.9 and 13.2-15.8); longer snout (12.4-13.6 vs. 8.2-9.7 and 7.9-11.4) respectively of *S. vinciguerrae* and *S. poculi*. Comparison of specific morphological characters of *S. tigrinum*, *S. vinciguerrae* and *S. poculi* are given in Table 1 and a detailed one for proportional measurements in Table 2.

Smith (1945) described *S. poculi* from northern Thailand (erstwhile Siam). Kottelat (1990) reported its distribution in Salween and Mekong basins and *S. vinciguerrae* in Chindwin-Irrawaddy basin. Although Kottelat (1990) reported that sexual dimorphism was not known in *S. vinciguerrae*, Menon (1987) observed the presence of sub-orbital flap in males of the species collected from Namya River. All the male specimens collected from Ukhrul district of Manipur (Chindwin basin) have a sub-orbital flap, and represent another species, *S. reticulata* (Vishwanath and Nebeshwar 2004).

The new species was also compared to *S. vinciguerrae* specimens in MUMF and found to have differences as follows: shallower body (14.4-15.9 vs. 16.7-17.9), longer head (26.1-27.9 vs. 18.3-21.3), longer snout (12.4-13.6 vs. 8.2-9.7), and wider head at nares (13.1-14.7 vs. 9.7-10.7).

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REFERENCES

Chaudhuri, B.L. (1912): Description of some new species of freshwater fishes from north India. *Rec. Indian Mus. 7*: 437-444.

Hora, S.L. (1921): Fish and fisheries of Manipur with some observations on those of Naga hills. *Rec. Indian Mus. 22*: 166-214.

Hora, S.L. (1937): Notes on fishes in the Indian Museum, XXXII. On a small collection of fish from the upper Chindwin Drainage. *Rec. Indian Mus. 39*: 331-350.

Kottelat, M. (1990): Indochinese nemacheilines, a revision of nemacheiline loaches (Pisces: Cypriniformes) of Thailand, Burma, Laos, Cambodia and southern Vietnam. Verlag, Dr. Friedrich Pfiel, Munchen. 262 pp.

Menon, A.G.K. (1987): The fauna of India and the adjacent countries. Pisces, Vol. 4, Teleostei: Cobitoidea, Part 1, Homalopteridae, 259 pp., 16 pls. Zoological Survey of India, Calcutta.

Smith, H.M. (1945): The freshwater fishes of Siam or Thailand. *Bull. U.S. Nat. Hist. Mus. 188*: 622.

Tilak, R. & A. Hussain (1990): Description of a New Loach, *Nemacheilus chindwinicus* sp. nov. (Homalopteridae. Cypriniformes) from Manipur, India, with Notes on the Systematic Status of the Genus *Nemacheilus* and the Subfamily Nemacheilinae. *Mitt. Zool. Berl. 66(1990)*: 51-58.

Vishwanath, W. (2000): Fish Fauna of Manipur. Manipur Assn. Sci & Soc. 143 pp.

Vishwanath, W. & J. Laisram (2001): Fishes of the subfamily Nemacheilinae Regan (Cypriniformes: Balitoridae) from Manipur. *J. Bombay Nat. Hist. Soc. 98(2)*: 197-216.

Vishwanath, W. & K. Nebeshwar (2004): *Schistura reticulata*, a new species of balitorid loach from Manipur, India, with redescription of *S. chindwinica*. *Ichchyol. Explor. Freshwaters 15(4)*: 323-330.

A NEW SPECIES OF *PUNTIUS* (CYPRINIDAE, CYPRININAE) FROM KERALA, INDIA[1]

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A new species of Cyprinid fish *Puntius muvattupuzhaensis* is described from the River Muvattupuzha, Ernakulam district, Kerala, southern India. It is a small, elongate *Puntius* species with characteristics: dorsal fin with unbranched principal ray osseous and serrated; lateral line (Ll) complete with 24-25 scales, lateral transverse scale-rows 4 between dorsal origin and lateral line, 2½-3 between lateral line and pelvic fin base, barbels absent, body with two spots on the flank: a shoulder spot below 4th Ll scale, and a caudal spot on 19th-21st Ll scales, dorsal fin without spots. Its affinity to the closest species, *P. punctatus* Day, and other related species is discussed. A key to Indian species, including the newly described one, having a strong, osseous and serrated principal dorsal fin ray, is provided.

Key words: Cyprinidae, *Puntius muvattupuzhaensis* sp. nov., Kerala

INTRODUCTION

Cyprinid fish of the genus *Puntius,* owing to their species diversity and abundance, are ubiquitous in almost all types of freshwater bodies of both lowland and highland areas. The genus is widely distributed in South and Southeast Asian countries. Our systematic understanding about the species and their diversity, particularly in the context of the Indian sub-region, is based primarily on the works of Day (1865, 1875-78, 1889); Jayaram (1981, 1999); Talwar and Jhingran (1991); Menon (1999), including the description of an additional species from Manipur, India, by Menon *et al.* (2000) who treated *P. punctatus* as a distinct species.

During an ichthyological survey in Ernakulam district, Kerala, the authors collected five specimens of the genus *Puntius* from River Muvattupuzha at Ooramana, near Muvattupuzha town. On detailed study, the specimens were found to be distinct from all known species. Based on this study, a new species *Puntius muvattupuzhaensis* is created. Standard practices (Jayaram 1999) were followed while taking measurements. Data are presented in percentages, with the mean value followed by range within parentheses. The type specimens are deposited in the Zoological Survey of India, Western Ghats Field Research Station, Calicut (ZSI/ WGFRS / CLT)

Puntius muvattupuzhaensis sp. nov. (Fig. 1)

Holotype: F. 12241, ZSI / WGFRS, CLT, (Zoological Survey of India / Western Ghats Field Research Station, Calicut), 48 mm SL, Muvattupuzha river, Ooramana, Ernakulam district, Kerala, India; 21.xi.2001; Coll. K.S. Jameela Beevi & A. Ramachandran.

Paratypes: Four specimens, 39- 48 mm SL; data same as for holotype.

Diagnosis: A small, elongate *Puntius* species without barbels; dorsal fin with an unbranched osseous and serrated principal ray; lateral line complete with 24-25 scales, lateral transverse scale rows 2½-3 between lateral line and pelvic fin insertion, body with two spots on flank: one small shoulder spot just below the 4th lateral line scale, and a caudal spot on 19th-21st lateral line scales.

Description: D. iii, 8; P. i, 11-13; V. ii, 7; A. iii, 5; C. 10+9. Body elongate, both dorsal and ventral profiles gently convex with predorsal part a little prominent. Depth of body 32.6 (30.4-34.9)% of SL; head small, its length 28.5 (26.1-33.3),

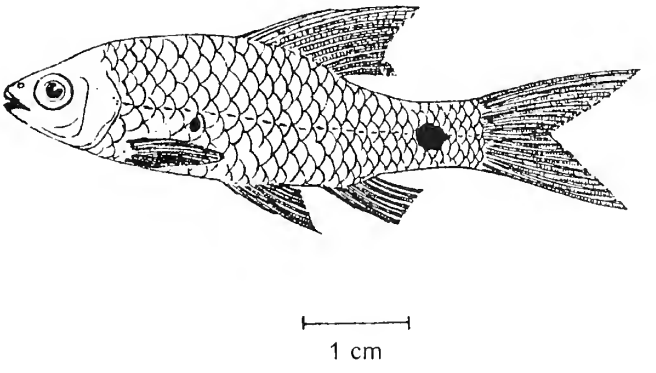

Fig. 1: Lateral view of *Puntius muvattupuzhaensis* sp. nov. Jameela Beevi & Ramachandran 48 mm SL. Holotype, F. 12241, ZSI/WGFRS, CLT

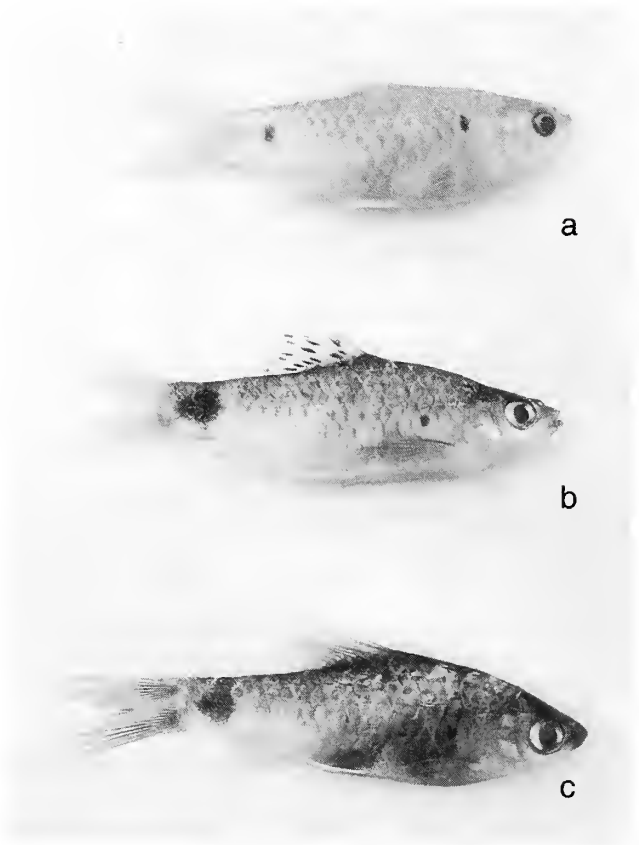

Fig. 2: Lateral view of similar *Puntius* species
a. Lateral view of *Puntius ticto;*
b. Lateral view of *Puntius punctatus*
F. 41-7/76 Estt. 86, ZSI, Chennai;
c. Lateral view of *Puntius muvattupuzhaensis* sp. nov.
48 mm SL. Holotype, F. 12241, ZSI/WGFRS, CLT

maximum depth 23.4 (21.7-25.0) of SL; snout short and smaller than eye, 24.4 (21.4-27.3) of head length (HL), 63.7 (60.0-66.9) of inter-orbital width (IOW); eyes large, its diameter 29.7(28.6-30.9) of HL, 94.3 (80.0-100.0) of IOW; mouth arched inferior; barbels absent.

Dorsal fin origin equidistant from tip of snout and caudal fin base, both the predorsal distance and postdorsal distance nearly the same, 51.0 (48.8-53.8) of SL, distal fin margin straight or slightly concave, principal spinous ray of dorsal fin strongly osseous, serrated, with a distal flexible portion, dorsal fin height 27.7 (23.3-33.3) of SL and 90.4 (83.3-97.4) of HL. Pectoral fin almost reaching ventral fin, its length 20.1(18.6-22.9) of SL, 70.9 (61.5-78.6) of HL, pre-pectoral distance 27.2 (26.2-29.2) of SL. Pelvic fin long and pointed, reaching anal opening, its length 21.1 (20.8-21.4) of SL, and 76.6 (71.4-81.8) of HL, pre-pelvic distance 50.6 (45.7-53.8) of SL. Anal fin long, nearly reaching caudal fin base, falling short of 2 or 3 scales from the latter, its length 67.9 (61.5-75.0) of HL, preanal distance 73.3 (69.8-76.9) of SL; caudal fin forked, its lobes pointed. Caudal peduncle depth 63.3 (62.5-70.0) of its length, 12.9 (10.9-14.3) of SL. Maximum length of body cavity 44.4(41.9-45.8) of SL.

Scales large; lateral line complete with 24-25 scales; scale rows in transverse series between dorsal fin origin and lateral line 4; 2½-3 scale rows between lateral line and pelvic fin base; predorsal scales 8.

Colour: Live specimen: olive green back, silvery on flanks and belly. Dorsal fin reddish; pelvic and anal fins golden yellow, pectoral and caudal fins faintly greyish. Two spots on flank: a black shoulder spot on the scale below the 4th lateral line scale, and a caudal spot inside a golden ring on scales 19-21. After preservation: upper half blackish with scales edged with fine black spots, lower half silvery white, with two distinct black spots on the body. Fins, dorsal greyish without spots, the other fins light in colour.

Distribution: INDIA: Kerala: Ernakulam (Muvattupuzha river).

Etymology: The new species is named after the river the fish specimens were collected from.

Remarks: The new species, *P. muvattupuzhaensis* is closely related to *P. punctatus* (Day) occurring in the southwestern extremity of peninsular India, and Sri Lanka. Both species have similar characters, namely complete lateral line, and identically placed shoulder and caudal spots on the body. However, *P. muvattupuzhaensis* is easily distinguished by its more elongate body (depth 32.6% SL vs. 36.4% SL in *P. punctatus*), including a narrow caudal peduncle (12.9% SL vs. 15.1% SL and 63.3% CL vs. 96.6% CL in *P. punctatus*), fewer lateral transverse scale rows (2½-3 vs. 4, in *P. punctatus*). Dorsal fin devoid of rows of spots (vs. rows of spots invariably present in *P. punctatus*). *P. muvattupuzhaensis* strikingly resembles *P. manipurensis* Menon, Rema Devi & Viswanath known from Manipur, in the northeast extremity of India, by having similar features like elongate body shape, and body spots, but differs from it in having a complete lateral line, fewer transverse scale rows between lateral line and pelvic fin insertion (2½-3 vs. 3½ in *P. manipurensis*).

The affinity of the new species to *P. ticto* (Ham.) is suggested by shared characters such as absence of barbels, dorsal fin with an unbranched, osseous and serrated principal spiny ray, and two black spots (shoulder and caudal spots) on body. *P. muvattupuzhaensis* sp. nov. belongs to the *ticto* group of species (Jayaram 1981) represented by *P. ticto* (Ham.), a species widely distributed in the Indian sub-region. The fishes of the *ticto* group exhibit considerable variation in their characteristics, which indicates a tendency towards speciation influenced by various isolating factors in far-flung geographical areas, such as northeastern and southwestern India. It is possible that these differences indicate an incipient stage in the formation of a new species. The new species,

P. muvattupuzhaensis can be presumed to have evolved from the parent stock of *P. ticto*, in southwestern peninsular India.

KEY TO *PUNTIUS* SPP. WITH A STRONG, OSSEOUS AND SERRATED PRINCIPAL DORSAL FIN RAY

1. Barbels (one pair of maxillary) present 2
— Barbels absent 3
2. Body depth 5 times in SL; a black spot over anterior part of anal base ..... *P. sharmai* Menon & Rema Devi
— Body depth 4 times in SL; no black spot over anterior part of anal base ..... *P. fraseri* Hora & Misra
3. Lateral line (Ll) scales 36 or more ..... *P. ambassis* (Day)
— Ll scales less than 36 4
4. Ll scales more than 30; predorsal scales 15 ..... *P. guganio* (Ham.)
— Ll scales less than 30; predorsal scales less than 15 5
5. Lateral transverse (Ltr) scale-rows 5½ / 5½ ..... *P. conchonius* (Ham.)
— Ltr scale-rows fewer 6
6 Ltr scale-rows between Ll and pelvic fin base 4-½ ..... *P. ticto* (Ham.)
— Ltr scale-rows between Ll and pelvic fin base less than 4-½ 7
7 Ll incomplete 8
— Ll complete 11
8 Ll series of scales 24 or more ..... *P. gelius* (Ham.)
— Ll series of scales less than 24 9
9. Body with a horizontal line on flank; caudal peduncle with two dark blotches ..... *P. shalynius* Yazdani & Talukdar
— Body without a horizontal line on flank; caudal peduncle without paired blotches 10
10 Body deep, with vertical bands; dorsal fin with a band and without spots ..... *P. phutunio* (Ham.)
— Body shallow, without bands, but with 2 spots; dorsal with 2 rows of spots ..... *P. manipurensis* Menon, Rema Devi & Viswanath
11 Ll with 20 scales ..... *P. setnai* Chhapgar & Sane
— Ll with more than 20 scales 12
12 Two widely separated black spots on body, anterior one above 3rd Ll scale and the posterior one before 19th Ll scale; dorsal fin without spots ..... *P. stoliczkanus* (Day)
— Two widely separated black spots on body, anterior one below 3rd Ll scale and the posterior one beyond 19th Ll scale; dorsal fin with or without spots 13
13 Ltr scale-rows 5/4; dorsal fin with rows of spots ..... *P. punctatus* (Day)
— Ltr scale-rows 4 / 2½-3; dorsal fin without spots ..... *P. muvattupuzhaensis* sp. nov.

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REFERENCES

DAY, F. (1865): The Fishes of Malabar, London. Repr. Bishen Singh Mahendra Pal Singh, Dehra Dun, India. Pp. 214-215.

DAY, F. (1875-1878): The fishes of India: being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma and Ceylon. London. Repr. Today and Tomorrow Book Agency, New Delhi. xx + 778 pp., 195 pls

DAY, F. (1889): The Fauna of British India, including Ceylon and Burma. Fishes, 1. Taylor and Francis. London. 548 pp.

JAYARAM, K.C. (1981): The freshwater fishes of India, Pakistan, Bangladesh, Burma and Sri Lanka. A Handbook. Govt. of India, i-xxii, 1-475, pls. XIII.

JAYARAM, K.C. (1999): The fresh water fishes of Indian Region. Narendra Publishing House. Delhi, 471 pp.

MENON, A.G.K. (1999): Check list – Fresh water fishes of India. *Zoological Survey of India, Occ. Pap, No.175*, pp 366.

MENON, A.G.K., K. REMA DEVI & W. VISWANATH (2000): A new species of *Puntius* (Cyprinidae: Cyprininae) from Manipur, India. *J. Bombay Nat. Hist. Soc. 97(2)*: 263-268.

TALWAR, P.K. & A.G. JHINGRAN (1991): Inland Fishes of India and adjacent Countries. Oxford and IBH Publishing Co. Pvt. Ltd., Vol. I: 373-379.

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A NEW FISH SPECIES OF THE GENUS *GARRA* HAMILTON-BUCHANAN (CYPRINIFORMES: CYPRINIDAE) FROM MANIPUR, INDIA[1]

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A new cyprinid fish of the genus *Garra* is described from the Khuga river of Churachandpur district of Manipur state, India. The species differs from *Garra lissorhynchus* (McClelland) in having a smaller number of: scales in lateral line (30-31 vs. 33-34), lateral transverse scale count (3/1/3 vs. 4/1/3), pre-dorsal scales (11-12 vs. 14), gill rakers (6 vs. 12). The fish also differs from *Garra rupecula* (McClelland) in having a smaller number of: gill rakers (6 vs. 8), scales on lateral line (30-31 vs. 34) and also in the presence of scales on the back. *G. rupecula* is characterised by the absence of scales on the pre-dorsal region. The new species also differs from both the species under comparison in its colour banding pattern on the caudal fin.

Key words: *Garra*, new species, *Lissorhynchus* complex, Manipur

INTRODUCTION

Menon (1964) reviewed the genus *Garra* Hamilton-Buchanan, and recognised 37 species. The important character of the genus is the possession of suctorial disc on the ventral surface of the head, just behind the mouth. Most of the species inhabit rapid running waters and adapt to the substratum, by means of the horizontally placed paired fins, especially the pectorals (Menon 1964). This genus is widely distributed in the hill streams of Manipur, India.

Hora (1921) described two new species, *G. abhoyai* and *G. naganensis* from the State and also recorded *G. nasuta* (McClelland). Menon (1964) while revising the genus *Garra*, considered *G. abhoyai* Hora to be a synonym of *G. rupecula* (McClelland). Vishwanath *et al.* (1987) recorded a Burmese form *G. gravelyi* (Annandale) and an Assamese form *G. kempi* Hora from the State. Vishwanath and Sarojnalini (1988) described *G. manipurensis* from the Manipur river. Vishwanath (1993) reported only three species of *Garra* in the *Lissorhynchus* complex, namely *G. lissorhynchus*, *G. rupecula*, and *G. manipurensis*, while reviewing the genus from Manipur. Kosygin and Vishwanath (1998) and Vishwanath and Kosygin (2000) described *G. compressus* and *G. elongata* respectively from the state.

In the collection of freshwater fishes of the Khuga river in Manipur (Chindwin drainage), 11 specimens of *Garra* which resemble species of *Lissorhynchus* complex were collected. These do not fit into the description of any known species of the genus. The fish is described here as a new species.

MATERIAL AND METHODS

Measurements and counts followed Menon (1964). Measurements were made with dial callipers to the nearest 0.1 mm and expressed in percentage of standard length (SL) or head length (HL). The type specimens of the new species are deposited in the Manipur University Museum of Fishes, MUMF.

Garra paralissorhynchus sp. nov. (Fig. 1)

Holotype: Female. MUMF 5054, 67.3 mm SL; Khuga river, Churachandpur district, Manipur, India; K. Shanta Devi. 25.vii.2000.

Paratypes: Sex not determined. MUMF-5041, 57.3 mm SL; MUMF-5053 & 5055, 2 exs. 58.6, 58.2 mm SL, 3.v.2000; MUMF-5074, 63.4 mm SL, 2.xi.2000; MUMF-5081 & 5094, 2 exs. 59.7, 60 mm SL, 10.iv.2000; MUMF-5103-5106, 4 exs., 53.7-63.4 mm SL, 21.viii.2002. Same collection data as Holotype.

Sexual dimorphism: None.

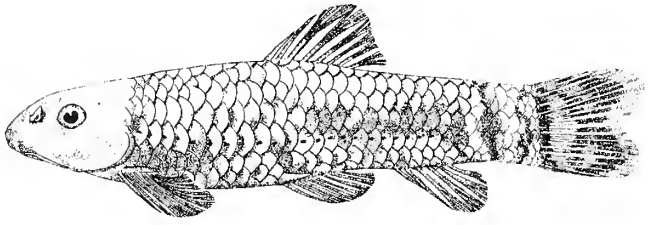

Fig. 1: *Garra paralissorhynchus* sp. nov.

Table 2: Comparison of *Garra paralissorhynchus* with related species [Readings are: Mean (range)]

		Garra lissorhynchus		*Garra rupecula*	
	Garra sp. nov.	Menon 1964	Iyei R. (Barak drainage) (MUMF collection)	Menon 1964	Singda R. (Chindwin drainage) (MUMF collection)
	N = 11	N = 33	N= 12	N = 64	N = 5
SL (mm)	53.7-67.3	31.5-73.5			
In % of SL					
Body depth	24.1(19.3-25.0)	19.7(15.2-22.5)	21.0(19.7-22.7)	17.6(16.2-24.0)	18.8(18.2-19.4)
In % of HL					
Head height	68.9(64.8-71.9)	57.5(51.8-63.3)	67.1(63.2-73.1)	59.9(50.0-69.9)	63.0(60.6-69.1)
Caudal peduncle length	56.4(46.9-62.6)	74.1(57.8-83.3)	85.6(82.2-91.2)	76.9(53.5-95.2)	78.2(71.9-86.0)
Caud- ped. Ped. width in its length	112.3(103.1-131.4)	73.5(63.7-84.7)	72.2(69.2-74.3)	72.5(57.8-89.3)	76.1(68.5-80.0)
Counts					
D	ii, 6	ii, 6	ii, 6½	ii, 6-7	ii, 6
A	ii, 4	i, 5	i, 4	i, 5	i, 4
L. l.	30-31	32-35	33-34	32-34	34
L. tr.	3/1/3	3-4/1/2-3	4/1/3	3/1/3	4/1/3
Predorsal scales	11-12	11-14	14	0	0
Gill rakers	6	7-9	12	7-9	8
Scales on mid-dorsal streak	Present	Present	Present	Absent	Absent
Colour of fins	Dorsal with transverse black bar and caudal with W-shaped band with vertical line and dots anterior to W-shaped band	Dorsal with transverse black bar and caudal with W-shaped broad band	Dorsal with transverse black bar and caudal with W-shaped broad band	Dorsal with transverse black bar and caudal with W-shaped broad band	Dorsal with transverse black bar and caudal with W-shaped broad band

Table 1: Morphological characters of *Garra paralissorhynchus* sp. nov.

	Holotype MUMF 5054 N = 1	Paratypes MUMF 5041, 5053, 5055, 5074 5081, 5094, 5103-5106 N = 10
Standard	67.3	53.7-63.4
In % of SL		Mean (Range) ± S.D.
Depth of body	25.7	24.1 (19.3-25.0) ± 2.2
Length of Head	23.2	24.1 (20.0-26.8) ± 2.0
Predorsal length	51.1	51.4 (43.9-55.3) ± 3.6
In % of HL		
Head width	81.4	82.1 (75.8-87.7) ± 3.4
Head height	70.5	68.9 (64.8-71.9) ± 2.6
Snout length	51.9	49.3 (46.8-57.7) ± 1.8
Eye diameter	17.9	20.4 (17.2-22.7) ± 1.9
Interorbital space	51.9	50.4 (43.6-55.3) ± 3.5
Pectoral fin length	93.6	94.1 (88.2-101.7) ± 4.8
Disc length	34.6	36.4 (33.3-41.9) ± 4.0
Caudal peduncle length	62.8	56.4 (46.9-62.6) ± 5.6
Disc width in head width	60.6	56.8 (54.2-59.8) ± 1.9
Disc length in disc width	70.1	72.7 (67.1-77.1) ± 3.1
Caudal peduncle height in its length	105.1	112.3 (103.1-131.4) ± 9.1
Space of V-A origins in V origin-caudal fin	61.1	58.8 (56.5-60.4) ± 1.4
Space of Vent-A origins in V-A origins	29.7	28.8 (25.0-30.8) ± 2.5

Diagnosis: A species of *Garra* with the following combination of characters: no transverse groove and proboscis on the snout, scales absent on chest and belly, a dark streak near the free margin of the dorsal fin, a thin and light black W-shaped band on the posterior half of the caudal fin and one or two dark vertical lines anterior to the W-shaped band, lateral line scales 30-31; pre-dorsal scales 11-12; lateral transverse scales 3/1/3, depth of body 19.3-25.0% of SL; caudal peduncle width 103.1-131.4% of its length, gill rakers 6.

Description: D ii, 6; P i, 11; V i, 7; A ii, 4; C. 9+8; L.l. 30-31; L.tr. 3/1/3. Pre-dorsal scales 11-12. Body short, rounded; head moderately compressed, snout semicircular, blunt without transverse groove and proboscis, a few tubercles present on snout and cheeks, inter-orbital region slightly convex. Barbels two pairs, one rostral and one maxillary, both shorter than the diameter of eyes. Oral disc well-developed, scales absent on chest and belly. Fins yellowish-white. Dorsal fin with a dark streak near the free margin, a thin and light black W-shaped band on the posterior half of the caudal fin with one or two vertical lines of black spots anterior to the W-shaped band, caudal fin slightly emarginate, gill rakers 6. Proportional measurements are given in Table 1.

Colour in formalin: Body dark grey, yellowish-white ventrally. Scales on sides of the body orange. A dark spot at the upper angle of the gill opening. Dorsal fin with a broad transverse black bar near the free margin. Caudal fin with a thin and light W-shaped dark band with lines of black spots anterior to it. Fins yellowish-white.

Etymology: The species is named so for its similarity to *G. lissorhynchus* (McClelland) in having a W-shaped dark band on its caudal fin.

Distribution: India: Khuga river, Churachandpur district, Manipur (Chindwin basin).

Discussion: *Garra paralissorhynchus* sp. nov. is similar to *Garra lissorhynchus* in having a snout without transverse groove and proboscis; naked chest and belly; a black bar near the free margin of dorsal fin and a caudal fin with a thin, light W-shaped dark band at the posterior end. However, it can be easily distinguished from the latter in having smaller number of: scales on lateral line (30-31 vs. 33-34), and pre-dorsal region (11-12 vs. 14), lateral transverse scale count (3/1/3 vs. 4/1/3), and smaller number of gill rakers (6 vs. 12). The new species has a deeper body (24.1 vs. 21.0% of SL), deeper head (68.9 vs. 67.1% of HL; and wider caudal peduncle (112.3 vs. 72.2% of its length). It also differs from *Garra rupecula* in having: scales on the back (*rupecula* does not have scales in the mid-dorsal streak in the pre-dorsal region), smaller number of: gill rakers (6 vs. 8), scales on lateral line (30-31 vs. 32-34). The new species also differs from both the species under comparison in its colour banding pattern on the body and caudal fin, as it has a vertical dark band anterior to the W-shaped bands. Thus, the new species is a member of the *lissorhynchus* complex, and may have evolved from a common ancestor. The comparison between the three species is given in Table 2.

REFERENCES

Hora, S.L. (1921): Indian cyprinoid fishes belonging to the genus *Garra* with notes on related species from other countries. *Rec Ind. Mus. 22*: 633-687.

Menon, A.G.K. (1964): Monograph of the cyprinid fishes of the genus *Garra* Hamilton. *Mem. Ind. Mus. 14(4)*: 173-260.

Vishwanath, W. (1993): On a collection of fishes of the genus *Garra* Hamilton from Manipur, India with description of a new species. *J. Freshwater Biol. 5(1)*: 59-68.

Vishwanath, W. & Sarojnalini, Ch. (1988): A new cyprinid fish, *Garra manipurensis*, from Manipur, India. *Japanese J. Ichthyol. 35(2)*: 124-126.

L. Kosygin & W. Vishwanath (1998): A new cyprinid fish *Garra compressus* from Manipur, India, India. *J. Freshwater Biol. 10(1-2)*: 45-48.

Vishwanath, W. & L. Kosygin (2000): *Garra elongata*, a new species of the subfamily Garrinae from Manipur, India (Cyprinidae, Cypriniformes). *J. Bombay Nat. Hist. Soc. 97(3)*: 408-414.

Vishwanath, W., H.T. Singh, O. Shashikumar & M. Gonchandra (1987): First records of freshwater fishes, *Garra gravelyi* and *G. kempi* in Manipur. *Indian J. Fish 34(3)*: 362-364.

REVIEWS

1. THE WAY OF THE TIGER: NATURAL HISTORY AND CONSERVATION OF THE ENDANGERED BIG CAT, 2002. By K. Ullas Karanth. Centre for Wildlife Studies, Bangalore. Pp. 132, Size: 26 x 24 cm. Hardback, Price: Rs. 495/-.

The Tiger is an icon for the conservation movement in India. During the last 50 years, more than a dozen books have been written about this magnificent animal – fortunately books on saving tigers have replaced *shikar* books. Dr. K. Ullas Karanth is one of the leading experts on the Tiger and its habitat. An engineer by education, he has devoted more than two decades to unravel the mysteries of tiger life. He obtained his Ph.D. studying predator-prey relationships in the famous Nagarhole National Park in Karnataka. He is an employee of the Wildlife Conservation Society, New York, but lives and works in India.

THE WAY OF THE TIGER shows Ullas Karanth's erudition and love of his subject. It is full of profound statements, based on the sound scientific knowledge of the author. The book has 14 chapters, with catchy titles, for example, 'Dressed to Kill', 'Solitary, But Not Alone', and 'The Enemy We Admire'. The lavishly brought out book is profusely illustrated with pictures of the Tiger, but I suspect that many pictures have been taken in captivity. Nonetheless, they are admirable. My favourite picture is on page 41, of a Siberian Tiger walking cautiously on obviously thin ice. Is it completing its future?

The book ends with the predictable question: Can we save the Tiger? I quote from Ullas Karanth's statement in the *Introduction* (p. 8) "There is no sure-fire way of predicting how successful we will ultimately be, but the more sensibly we act now, the greater is the chance that the tiger will survive the twenty-first century. Mere doomsday prophecies, however well-intentioned, discourage rational conservation action, and may be harming rather than helping the tiger's cause. My view is that, on the basis of biological facts and historical background, the tiger is not yet a lost cause". I think the Tiger (and other wildlife) can be saved on the basis of effective conservation measures based on good science. And, ultimately, when it comes to basics, Tiger and Tiger habitats have good reasons to be protected because when "we protect tigers forests from logging, overgrazing, fires and conversion to cropland, we are not indulging in a luxury that we cannot afford in a poverty-stricken, overpopulated world. We are, in fact, protecting the soil-water resources that sustain millions of people in Asia". This is enough reason to protect the Tiger and its habitats all over its distribution range. This book would help in securing the future of the Tiger, as the proceeds from its sale will be used for Tiger conservation.

■ ASAD R. RAHMANI

2. THE RETURN OF THE UNICORNS: THE NATURAL HISTORY AND CONSERVATION OF THE GREATER ONE-HORNED RHINOCEROS, 2003. By Eric Dinerstein. Columbia University Press, New York. Pp. 316, Size: 23 x 15.5 cm. Hardback, Price not stated.

This book is a part of the Biology and Resource Management Series, published by the Columbia University, USA. It praises the author for being "directly responsible for the recovery of the greater one-horned rhinoceros in Royal Chitwan National Park in Nepal". With such a statement on the dust jacket, it is to be expected that not much importance is given to the effective and praiseworthy initiatives taken by the Nepal government since 1954, much before Eric Dinerstein came on the scene in 1972. The language of the book is patronizing, and the underlying message is that if the great American scientists had not been to Nepal, the rhinoceros would have disappeared, because the poor Nepalese do not know how to take effective conservation measures. The fact is that despite poverty and pressure on land, the Nepal government has taken many conservation measures, setting an example for many western countries.

As far as science is concerned, the book is fine. Eric has collated all the available literature on the Greater One-horned Rhinoceros and embellished it with his own research. It is interesting to know that in zoos, males are bigger, but no size difference is seen in nature (p. 77). Females have longer horns, and in males, the incisors are the major weapons of offence (p. 76). The book is well designed and edited. It has a separate method section, which does not interfere with the flow of the general text. Headings and subheadings also help in sectioning this 316-page book. Eric has combined passion with scientific vigour. However, his condescending attitude shows everywhere, especially in Part III of the book where he has suggested various conservation measures. On page 247, he mentions that the World Wildlife Fund-United States (the

USA section of WWF has not changed its name to World Wide Fund for Nature), in collaboration with the Wildlife Conservation Society (based in New York), has identified 159 tiger conservation units. Surprisingly, there is no mention of the studies done by the Wildlife Institute of India in identifying such conservation units. On page 248, he mentions the important role of multilateral and bilateral funding agencies, international conservation organisations, foundations, individual philanthropists, international zoo community, and national governments in financing large-scale conservation. He has failed to mention that if the Washington-based World Bank, which has been funding and still is funding some of the biggest nature destruction projects in the world (including Nepal), stops funding such projects and takes a more conservation-based approach to development, perhaps we would not require these multilateral and bilateral funding agencies and their 'experts' for conservation initiatives in developing countries. I am sure the Nepalese are quite capable of looking after their Greater One-horned Rhinoceros. In one place, Eric has accepted that "a country like Nepal, extremely poor and lacking in infrastructure, is restoring endangered species populations. Other countries, both developed and undeveloped, have no excuse not to try." I hope Eric will spread the message of conservation of large mammals in his own country, which is incidentally the largest consumer of wildlife products, and where hunters and ranchers oppose the introduction of so-called dangerous animals, like the Timber Wolf, in wilderness areas. The consumer country in which Eric lives should also learn to live with nature – the way he wants the poor Nepalese to live with the Tiger and the Rhinoceros. In the revised edition, perhaps this could become the main message of this book.

■ ASAD R. RAHMANI

3. LIFE AT THE ZOO: BEHIND THE SCENES WITH THE ANIMAL DOCTORS, 2004. By Phillip T. Robinson. Columbia University Press, New York. Pp. 293, Size: 21.5 x 17.5 cm. Hardback, Price not stated.

LIFE AT THE ZOO seems to hold little promise in its initial stages of examination. There is every indication that this is just another first-person account of some retired director or veterinarian's experiences, the kind of book that I "inhaled", as one would a favourite food, when I was new to the zoo profession. But I am old now, and cynical, so chapters entitled "Intern at the Zoo", "Growing Pains", "Zoo Babies" give ME pains and I groaned every time I thought of actually reading the book before writing this review. So I put it off, and when I could do so no longer, tried my tested and true tricks for writing a book review without reading the book, tricks well practiced since high school. I read the last chapter, entitled "What a Zoo Should be". To my surprise, I couldn't put it down. Dr. Robinson has summed up almost everything I and a good part of the world's zoo community spent the better part of 18 months writing in a participatory manner for the World Zoo and Aquarium Conservation Strategy. Then I read the next to last chapter, entitled "Ethical Captivity: Animal Well-Being in Zoos", and again, found it to be very good reading indeed.

Then I sampled the Introduction where Dr. Robinson states his purpose for writing the book: "to share some hard-earned insights into the dynamics of caring for and conserving wild animals in captivity, as well as to consider a few broader implications for how we view nature and animals in our society," I realised then that Robinson was, of course, writing for the public, and it was necessary to explain many things about how it is with zoos, day by day, before going for the kill: explaining zoos' take on ethics and welfare, and wildlife conservation in a way that would permit readers to understand the "big picture" of zoo management and its future, and perhaps change some of their biases and old ideas.

Robinson says "This book will not tell you how to run a zoo, but it may give you a better idea of what to be pleased or perplexed about when you visit one in the future." And that it does. I would say that many zoo managers and veterinarians and policy makers, particularly in regions of the world where the zoos are not very good, could learn quite a lot about how to run a zoo from this book. Certainly the public and even conservationists (who think they know all about zoos, but don't) will have an excellent background on which to base a zoo visit and a framework in which to shape their attitudes and opinions, if they are willing to learn. I learned something – many things – from this book, including particularly how very much veterinary medicine and animal welfare have improved in the latter decades. For example, Dr. William Hornaday, Director of the Bronx Zoo in the early years, objected to isolating newly arrived primates in a quarantine and acclimatization period upon their arrival, stating that "monkeys could be replaced when needed and did not justify the labour and expense of the proposal" (p. 23).

Although this volume may be of particular interest to Americans, having somewhat more about American zoo history and management than that of other countries, it is clear that most aspects of zoo management and politics are quite similar anywhere you go.

Directors and veterinarians very often clash, for example, a phenomenon I noticed since two decades ago in India. Robinson comments (dryly) that it was the "natural order of things that veterinarians were predestined to impinge upon well-established territories." Although vets are needed, wanted, revered and feared, they are also resented, and Robinson describes this brilliantly. Vets feel that no institutional priorities should be more important than animal health, and their demands for better equipment, facilities for the animals – items which are prophylactic are often resented. Also (good) vets won't be happy concentrating merely on sick animals; they want to poke their noses into the condition of the healthy ones as well, thinking (rightly) that simple health problems ignored today, end up as complex and possibly fatal later. As Robinson is a veterinarian, his book settles quite a few scores of that profession, and he is spot on.

Throughout the book Robinson touches on almost every possible subject of interest or importance to zoos: history, management, medicine, nutrition, hand-rearing baby animals, zookeepers, zoo exhibits and housing, immobilisation, education, chimpanzee tea parties, docents (volunteers), visitors (and their immense variety of insanity), ethics, welfare, legislation, associations, conservation, etc.

An example of Robinson's wise comments on zoodom is his railing at the hypocrisy and irony of the horror zoo personnel have today of the word "cage". In the modern zoo. animals don't live in "cages"; they should have "captive environments", "zoo habitats", and "captive ecosystems". While the theory behind this is all too right – sterile cold concrete and iron boxes are not good homes for wild animals – nonetheless, says Robinson, "when all is said and done ... a "cage or habitat" represents the physical world that limits an animal's resources. A poorly designed or managed "captive ecosystem is no better than a lousy cage"! Having seen hundreds of "open moated" horrors which favour the visitor with a beautiful diorama while ignoring the myriad needs of the animal (a large space doesn't necessarily make a "happy" or stress-less animal), I hope some of the designers in South Asia will read this book.

It is in the chapters "Ethical Captivity – Animal Well-Being in Zoos" and "What a Zoo Should Be: and Ought Not to Be" that Robinson brings together much of the information disseminated in the previous sections. Ethical Captivity reviews the history of animal welfare in the zoo, including the various actions and activers, which brought it into being (he gives much credit to the American Animal Welfare Act and to the American Zoo Association accreditation process and to veterinarians for American Zoos). He reviews the major animal rights organisations, fairly I believe, and also the grey areas where even zoo personnel (such as zookeepers in particular) do not like what their superiors at the policy level do in zoos. He discusses the difficulty of establishing a uniform standard of welfare when human perceptions of what is right and wrong for animals differs so much ... personal bias, religion, habit.

Likewise, there is no exact method for assessing "well-being" of zoo animals. Robinson relates the example of the accepted norm of exhibiting animals in family or social groups rather than as solitary animals. Yet, he points out, this is sometimes in conflict with the natural habit of some animals to *be* solitary and only meet at certain times for breeding and infant rearing.

An example of this sort of irony from India fits nicely here. It seems that a bear rescue facility (these come under Central Zoo Authority now) was about to be censured and made to remodel its housing because they did not have individual cubicles for holding and feeding, as demanded by the Norms and Standards of the Zoo Act. However, the concerned Sloth Bears were those "dancing bears" which had been surrendered by their owners who had had them in company since the time they were cubs. These bears could not bear to be isolated. The facility had learned this the hard way with many miserable bears until they put them into groups, and that is what made them happy. No fighting, no competition. Fortunately, the CZA Member Secretary was sensible and open-minded, and made an exception for this case.

Training animals for shows, roadside zoos, bad city zoos, when People for Ethical Treatment of Animals was almost upstaged by People for Eating Tasty Animals, surplus animals, euthanasia, and more are covered in this potent chapter. Euthanasia is a hot topic in India today, when zoos refuse to give a merciful death to infirm and incurable animals. Culling, of course, is unheard of in India where it is better to release surplus animals into the wild where one can't see what becomes of them, or what their presence does to the resident wildlife or to the habitat, than to simply put them down.

Robinson makes a very good point about conservation, which leads into the final chapter when he discusses zoo publicity efforts and a gullible press and public have eaten whole isolated reports of a few successful reintroductions. Robinson opines, very likely correctly, that "this has served to lull some of the public into a false sense of complacency, relying too much upon the potential of zoos as safety nets for species extinctions"!

The last chapter describes modern conservation efforts, which do not rely so much on reintroducing

threatened or extinct species in the wild, as on providing funds for field work, research and habitat protection and on partnering with a variety of environmental, conservation and wildlife organisations to *prevent* extinction on the ground rather than *fix* extinction in the zoo. Small grant programmes help wildlife and habitat research, education and encouraging local capacity building. Zoos that wish to make a difference in conservation can pool resources so that both large and small, rich and poor zoos can collaborate and become involved in habitat preservation and field research.

Robinson describes the Canada goose as an "excellent example" of collaboration and its value and efficiency. These geese – travelling in a 'V' shape – are able to fly longer distances and more swiftly because of the aerodynamics of formation flying. The lead goose surrenders his turn at the head of the formation when tired, and another takes over so that the group can fly distances that a single goose could never manage alone. Robinson suggests "flying in formation, so to speak, Zoos and zoo people can go much farther together than their individual ever could in contributing to wildlife conservation."

Many lessons and much entertainment for all in this fascinating, frank and fair-minded book.

Robinson is a board certified veterinarian who began his training as a wildlife biologist at Michigan State University, conducting WWF sponsored graduate work in the rainforests of West Africa (Liberia and Sierra Leone). He was involved in the field feasibility studies in eastern Liberia that lead to the creation of Sapo National Park and has published numerous papers on the clinical problems of zoological species and on wildlife conservation in West Africa. He began his zoo career as a zoo vet as an intern at the San Diego Zoo and directed the Veterinary programme for a decade. Following that he was Director of veterinary services and animal resources at UC, San Diego; his responsibilities included a large biomedical research and training program. He was a founding member of the American College of Zoological Medicine and past president of the American Association of Zoo Veterinarians. Robinson has served on the design team for a number of important zoo veterinary hospitals in the USA. Throughout his career he has looked at the zoo, its denizens both two and four footed, its bosses and visitors and even its enemies with unsentimental, perceptive and "fair-critical" eyes, always noting both good and bad.

■ SALLY WALKER

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MISCELLANEOUS NOTES

1. DID TIGERS *PANTHERA TIGRIS TIGRIS* PASS THROUGH THE INDUS DELTA?

Maps and documents dealing with the former range of the Tiger in Pakistan show its known historical occurrence often not further south than 28.8° N nor further north than 30.0° N, and date hardly more than a hundred years back. With three locations for the Tiger along the Sutlej on his map, Mazak (1983) concluded that the species had surely advanced here from North India, although there is a gap of about 500 km towards his next Tiger location, further east along latitude 30.0° N. Today's global tiger distribution maps are often based on Mazak's interpretation (Fig. 1a). This note will make evident that

– tigers in Pakistan were formerly found as far north as 33.8° N and that

– tigers might have also found their way via Kachchh from India into Pakistan and inhabited the Indus Delta as far south as 24.0° N (Fig. 1b).

But at the beginning of the 20th Century the doomed Tiger population in Pakistan was already totally isolated (Fig. 1c).

Newall (1887, p.183) hunted in 1854 in the jungle at the foothills near Village Noorpore, between Rawalpindi and Murrie, and mentioned "there were also one or two tigers near Noorpore, but we never came across them. One, however, was shot over water by Palliser". Burton (1952, p.849) wrote "in 1852 a tiger killed an officer of the 98th Regiment 23 miles from Rawalpindi." (Coordinates of Rawalpindi: 33.7° N, 73.1° E).

At the time when Alexander (about 325 BP) visited India, the Indus Delta was located further east and the coastline of the Arabian Sea extended further north-east into the navigable Eirinos Bay with the Samara Sea (25.0° N, 69.4° E) at the mouth of the easternmost Indus branch. Possibly due to tectonical forces, connected with the uplift of the Indian subcontinent and the raise of the Himalaya, the Indus Delta then shifted westwards. The Eirinos Bay shrank, became more and more dry and formed, approximately since the 11th Century, a salt marsh known as Rann of Kachchh. According to Wilhelmy (1966, 1968), who analysed historical geographical descriptions of two millennia, the last major westward change in the course of the Indus happened in 1758/59, after which only one main branch of the Indus enters the ocean, whereas earlier there had been up to 6-7 widespread branches.

Today's desert regions east of the Indus, Thar Desert and Rann of Kachchh, may suggest that this arid zone was an impenetrable barrier for most terrestrial animals. But taking the former extent of the Indus Delta towards the east into

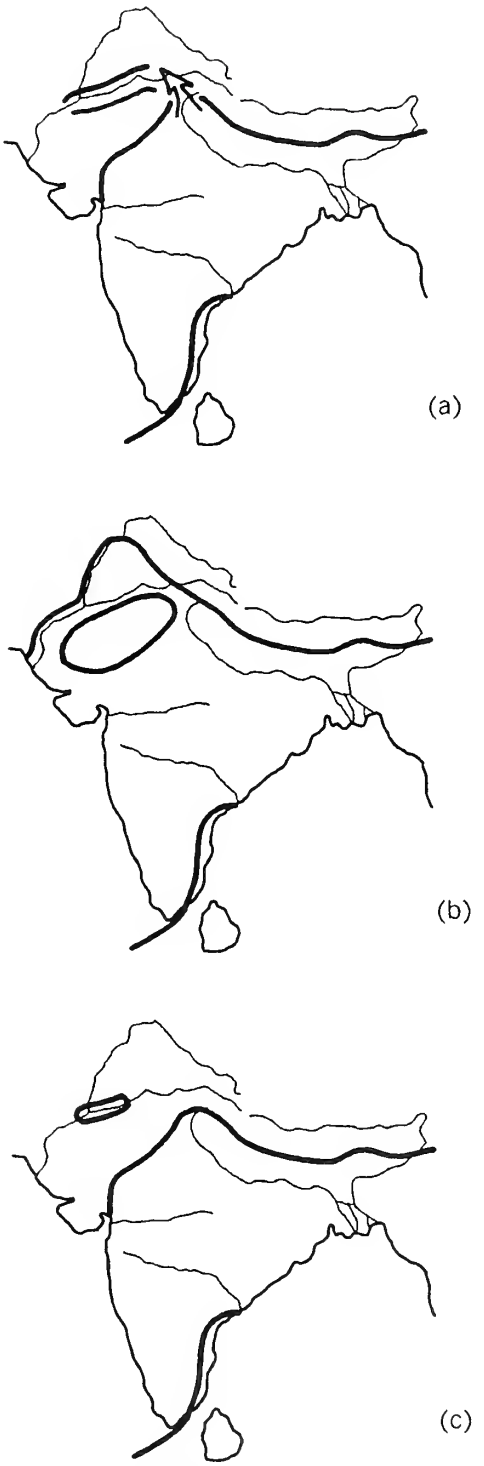

Fig.1: Tiger distribution maps, based on data of Mazak (1983)
(a) Mazak's interpretation (for the time around 1900)
(b) new interpretation (for several hundred years ago)
(c) new interpretation (for the time around 1900)
with isolated tiger population in Pakistan

account, a rich vegetation belt with the function of a zoogeographical east-west bridge comes into consideration. Thus, it is possible that the Tiger once found its way west through the old Indus Delta, and went from there further north along the Indus.

The following lines summarise some additional information regarding the former distribution of the Tigers and its prey in Pakistan.

According to Roberts (1997), the middle and lower Indus (in Punjab and Sind) were once surrounded by a continuous belt of tamarisk *Tamarix dioica* jungle four to twelve miles wide, and tall cane grass *Saccharum munja*, inhabited by wild boar and hog deer. A few hog deer are still found on some tamarisk-studded islands in the mouth of the Indus. Therefore, there are good reasons to believe that Tigers, in conformity with the distribution of their prey base, existed once throughout the riverine tracts, including the Indus Delta.

As known from the Ganga Delta, Tigers have no problem living in a brackish and marshy environment. Compared to the Ganga Delta, the Indus Delta is not merely a mangrove forest, but consists, besides a small mangrove belt along the coastline, predominantly of tall grass and dense tamarisk thickets. While surveying the Indus Delta in 1837, Carless (1838) wrote: "In the woods wild hogs abound, and there is also an animal very common in the interior, which from the description, must be the elk ... A lynx and a leopard were seen, and tiger-cats three or four times." His 'elks' were obviously hog deer and his 'lynx' was maybe a caracal. The old term 'tiger-cat' was usually used for lesser cats and could mean here the fishing cat. Perhaps Carless' leopard was a tiger, as leopards are not reported by Roberts (1997) from these environs.

Murray (1884): "In Sind, the tiger happily is not common. It is found in the Khairpur State [northern boundary at 28.5° N, southern boundary at 26.0° N], but there are not many records of its causing destruction. In Lower Sind nothing is heard of it. From Sukkur (27.7° N) upwards it is said to occasionally issue from its cover, which is the dense fringe of tamarisk bushes and long grass along the banks of the river, visit the cultivated parts and carry away stray cattle." Langley (1860, p.152) wrote: "In Upper Sind tigers are rarely seen on the left bank of the river, but in Hyderabad country they are frequently met with, and many of the poor beaters were their victims in the grand battues." Hyderabad country is located south of Khairpur State in Lower Sind and includes the region of the Indus Delta (towards 24.0° N).

Burnes (1834b, p. 141) admired a Tiger hunt of some sheikhs in Punjab and Newall (1887, p. 437) characterised passages of the river with "the dense grassy reaches down which a wandering tiger often strolls" when travelling down the Sutlej towards Bahawalpur in the summer of 1848. According to Roberts (1997), who reported shootings of 13 tigers in Punjab by an Amir of Bahawalpur State, the last tiger in Pakistan was shot in 1906 a few miles below Panjnad (about 29.3° N). The last survivor in Sind was shot in 1886 (Burton 1952, Eates 1968).

Macmurdo (1820, p. 215), when describing the province of Kachchh and the countries between Gujarat and the Indus, listed the Tiger at first position among the wild animals found there. Burnes (1834a, p. 103) stated that tigers were present along the Luni river in southwest Rajasthan (which falls into the Rann of Kachchh at about 24.5° N) and Stoliczka (1873, p. 226) wrote "both the lion and the tiger extremely rarely occur as stragglers from Kathivar, they had been formerly shot in Kachh territory, and a century ago they might have been more common". Campbell (1880, p. 30) believed "at the beginning of the century, lions, tigers, and other large game were plentiful in Cutch. But of late years, tigers and lions have almost entirely disappeared." According to these deliveries a zoogeographical bridge via Kutch towards the tiger distribution along the Indus river in the west seems to be imaginable. This speculation becomes quite plausible when taking the geographical changes of the delta into account.

Even today, the Indus Delta has considerable potential as a wildlife reserve, as Mountfort (1969, p. 189) judged. In fact, it would be the only suitable location for re-introducing tigers into Pakistan, although it is quite illusory to believe that high authorities as well as local communities could agree and find ways for solving financial, technical and scientific questions in adherence to the IUCN re-introduction guidelines. To keep this option open, however, the ecosystem of the Indus Delta, including the threatened hog deer population, should be well preserved.

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REFERENCES

BURNES, A. (1834a): Papers descriptive of the countries on the north-west frontier of India. *J. Roy. Geogr. Soc. 4*: 88-129.

BURNES, A. (1834b): Travels into Bokhara. Murray, London. Vol. 3.

BURTON, R. (1952): A history of shikar in India. *J. Bombay Nat. Hist. Soc 50*: 845-869.

CARLESS, T.G. (1838): Memoir to accompany the survey of the Delta of the Indus, in 1837. *Journ. Geogr. Soc. 8*: 328-366.

CAMPBELL, J.M. (1880): Gazetteer of the Bombay Presidency. Vol. 5 Cutch, Palanpur and Mahi Kantha. Bombay.

EATES, K.R. (1968): An introduction to the vertebrate fauna of Sind and

Khairpur State. West Pakistan Gazetteer – Sind Region. Government of West Pakistan. Mammalia, pp. 33-52. (cited by Roberts, 1997).

Langley, E.A. (1860): Narrative of a residence at the court of Meer Ali Moorad; with wild sports in the valley of the Indus. Hurst and Blackett, London. Vol. 2.

Macmurdo, J. (1820): An account of the province of Cutch, and of the countries lying between Guzerat and the river Indus. *Trans. Lit. Soc. Bombay 2*: 205-241.

Mazak, V. (1983): Der Tiger. Neue Brehm-Buecherei, Wittenberg. 3. Ed. pp. 44-45.

Mountfort, G. (1969): The vanishing jungle. Collins, London.

Murray, J.A. (1884): The vertebrate zoology of Sind. Richardson, London. pp. 24-27, 402.

Newall, D.J.F. (1887): The highlands of India. Reprinted by Logos Press, New Delhi 1984. Vol. 2.

Roberts, T.J. (1997): The Mammals of Pakistan. Oxford University Press, Karachi. 2nd ed.

Stoliczka, F. (1873): Notice on the mammals and birds inhabiting Kachh. *J. Asiatic. Soc. Beng. 41(2)*: 211-258.

Wilhelmy, H. (1966): Der wandernde Strom. *Erdkunde 20*: 265-276.

Wilhelmy, H. (1968): Indusdelta und Rann of Kutch. *Erdkunde 22*: 177-191.

2. AN INSTANCE OF ADOPTION IN THE INDIAN FLYING FOX *PTEROPUS GIGANTEUS* (CHIROPTERA: PTEROPODIDAE)

Parental care among mammals is complex and species specific. Diverse forms of parental care have arisen among mammals, primarily determined by the precocity of the young. In practically all mammals, mothers accept only their own young for suckling and parental care. A major downside of parenting is that when an animal cares for young, it must forgo some other activities such as searching for food or mates (Alock 1998). The males of primates such as *Presbytis entellus* (McCann 1934) and *Presbytis eristalus* (Bernstein 1968) respond to individual infants in distress. Among bats, McCann (1940) reported an instance in *Rousettus leschenaulti*, where a young one had deserted the body of its dead mother and gone to another which already had a suckling young one.

Mother-infant contact in some species is intense and uninterrupted throughout the early period (Simonds 1965). In bats, during the first few days of life, the young would be carried during foraging flight (Griffin 1940). Mortality among bats is highest between the onset of independent flight and the end of the first year of life (Brosset 1962, Davis 1966). Social organisation serves to minimize this mortality (Bradbury 1977).

Communal raising of young is exhibited by some bats (Bradbury 1977). Two to ten adult females are found to take care of the young in the nursery roost at all times (O'Farrell and Studier 1973). Gopalakrishna and Badwaik (1993) reported that lactating females of *Miniopterus schreibersii fulginosus* and *Rhinolophus rouxi* visit the groups of young left behind periodically, and suckle them on a community feeding basis. However, in *Hipposideros speoris*, mother and young recognise each other, and the mother suckles only her baby (Gopalakrishna and Badwaik 1993). Females of several other bats also specifically identify young (Kulzer 1958; Nelson 1965; Pearson *et al.* 1952, Davis *et al.* 1968). Incidence of adoption has been reported in some primates (Itani 1959, Rowell 1963). However, instances of adoption have rarely been observed among bats, though community raising and community suckling have been reported.

Since 1995, the authors have been regularly observing the feeding, roosting and breeding biology of *Pteropus giganteus* in south Kerala. During April 2000, a female bat with her attached young (B_1), was recovered along with another young (B_2), whose mother died soon. B_2, the orphan, was smaller although born during the same season. The bats thus recovered were housed in a netted cage (1.5 x 1 x 1 m) for observation. Initially the mother bat, with her attached young, hung on one corner of the cage, while the orphaned young hung at the opposite corner, vocalising continuously. The expectation was that the female bat would be antagonistic to the orphan because it had a baby of its own. As the orphan was in early infancy, an attempt to hand feed it was unsuccessful. Surprisingly, the following morning the mother bat was nursing both the young ones – one attached to each nipple (Fig. 1). In fact, the mother bat had moved with its attached young one to the corner where the orphan was hanging.

Since then, the two young bats remained attached to the female, exchanging nipples occasionally. After a week, the bats were left free in a larger netted shelter (8 x 5 x 3 m), where they could move freely and even fly. At dusk, fruits like banana, papaya and cashew were provided with water *ad libitum*. In the morning, both the young ones were closely wrapped by the mother bat, probably a mechanism for thermoregulation, while at night she left them and went to the food tray. This is reflective of the wild, where mother bats leave young ones at nursery sites while foraging. Occasionally she carried the young ones during the night. By the end of April, they moved independently at night and started eating or at least biting at fruits.

In May, two more young female bats could be recovered from the same roost, they were found attached to small plants below the roost. These young ones (B_3 and B_4) could also have been born during the same season as B_1 and B_2. B_4 was larger than B_3 and the two were introduced into the bat shelter.

Initially, B_3 and B_4 remained away from the others (Fig. 2). At night all the young bats, except B_2, carried fruits from the food tray to different locations and fed independently, a foraging pattern exhibited in the wild where individuals carry fruit for consumption away from the group foraging tree. B_2, which was

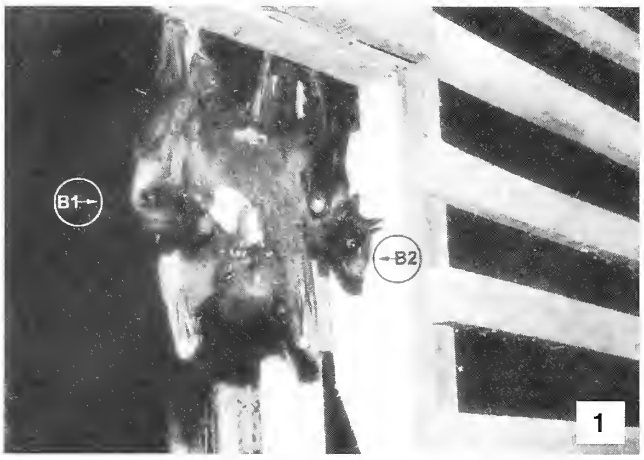

Fig. 1: B1 the original young, and B2 the orphaned young remaining attached to the mother bat

Fig. 2: B3 and B4, the orphans collected later, hanging separately, while B1 and B2 remain attached to the mother bat

Fig. 3: B4 approaching foster mother bat and dislodges B2 to get itself adopted

Fig. 4: All three young B1, B2 and B4 taking turns to feed as B3 remains independent

too small, was still carried by the foster mother during the 'foraging trips'. Subsequently, B_3 and B_4 started 'roosting' close to the other captive bats during the day. Towards the end of May, B_4 was seen hanging close to its foster mother bat and licking her wings and neck, after which it started feeding from her nipple, displacing B_2 (Fig. 3). Subsequently all the three young ones (B_1, B_2 and B_4) were found covered by the mother bat's outstretched wings. Evidently, B_4 was also accepted by the foster mother. The three young ones took turns to feed, as only two could feed at a time, and this relationship continued. B_3 remained independent (Fig. 4).

The reason for B_4 being adopted, while B_3 was not, cannot be explained. Possibly B_3 did not approach the foster mother, hence she did not respond. Neither did B_3 vocalise like B_2. In the earlier instance, the foster mother moved towards B_2, quite probably in response to repeated vocalization. In the subsequent instance, unlike B_2, B_4 approached the foster mother. Both the behavioural interactions resulted in adoption.

From July, the mother bat ceased to lactate and started tightly folding her wings around her body to prevent the young ones from suckling, but they continued sucking the nipple. This could be the weaning stage. Such signs of alienation are observable in the field also, when nursing mothers refused to feed during the same period and adult males started chasing attached young ones from their mothers.

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REFERENCES

ALOCK, J. (1998): Parental Care. *In*: Animal Behaviour (Ed.: Alock, J.). Sinauer Associates Inc. Sunderland. Massachusetts. 527 pp.

BERNSTEIN, I. (1968): The Lutong of Kaula Selangor. *Behaviour 32(1/3)*: 1-16.

BRADBURY, J.W. (1977): Social organisation and communication. *In*: Biology of Bats (Ed: Wimsatt, W.A.). Academic Press, New York. Pp. 1-72.

BROSSET, A. (1962): The bats of central and western India, Part I. *J. Bombay Nat. Hist. Soc. 59*: 1-57.

DAVIS, W.H. (1966): Population dynamics of the bat *Pipistrellus subflavus*. *J. Mammal. 47*: 383-396.

DAVIS, W.H., R.W. BARBOUR & M.D. HASSELL (1968): Colonial behaviour of *Eptesicus fuscus*. *J. Mammal. 49*: 44-50.

GOPALAKRISHNA, A. & N. BADWAIK (1993): Breeding habits and associated phenomena in some Indian bats, Part XIV (concluded). *J. Bombay Nat. Hist. Soc. 90(1)*: 1-9.

GRIFFIN, D.R. (1940): Notes on the life histories of New England cave bats. *J. Mammal. 21*: 181-187.

ITANI, J. (1959): Parental care in wild Japanese monkey, *Macaca fuscata fuscata*. *Primates 2(1)*: 61-93.

KULZER, E. (1958): Untersuchen uber die Biologie von Flughunden der Gattung *Rousettus*. *Z. Morphol. Oekol. Tiere 47*: 374-402.

MCCANN, C. (1934): Observations on some of the Indian langurs. *J. Bombay Nat. Hist. Soc. 36(3)*: 618-628.

MCCANN, C. (1940): Notes on the fulvous fruit-bat (*Rousettus leschenaulti* Desm.). *J. Bombay Nat. Hist. Soc. 41*: 805-816.

NELSON, J.E. (1965): Behaviour of Australian Pteropodidae (Megachiroptera). *Anim. Behav. 13*: 544-557.

O'FARRELL, M.J. & E.H. STUDIER (1973): Reproduction, growth and development in *Myotis thysanodes* and *M. lucifugus* (Chiroptera: Vespertilionidae). *Ecology 54*: 18-30.

PEARSON, O.P., M.R. KOFORD & A.K. PEARSON (1952): Reproduction of the lump-nosed bat (*Corynorhinus rafinesquei*) in California. *J. Mammal. 33*: 273-320.

ROWELL, T.E. (1963): The social development of some rhesus monkeys (1961 seminar). Pp 35-49. *In*: Determinants of Infant Behaviour (Ed.: Foss, B.M.), Vol. II. Methuen, London.

SIMONDS, P.E. (1965): The bonnet macaque in South India. Pp. 175-196. *In*: Primate Behavior (Ed: DeVore, I.) Holt. New York.

3. NEW SITE RECORD FOR SMALL TRAVANCORE FLYING SQUIRREL *PETINOMYS FUSCOCAPILLUS FUSCOCAPILLUS* FROM KARNATAKA

As part of a mammalian study, we surveyed the forests of Brahmagiri-Makut during November 2001 and January 2002. The forests of Brahmagiri-Makut lie between 12° 5'-12° 13' N and 75° 50'-76° 3' E, and form the southern tip of the Western Ghats in Karnataka, in the district of Kodagu. Elevation varies from 60 m above msl to 1,650 m above msl. The area receives both southwest and northeast monsoon and the average annual rainfall is about 6,000 mm. The region includes three forest ranges, namely Srimangala, Makut (Wildlife) and Makut (Reserve Forest). Srimangala and Makut (Wildlife) are a part of the Brahmagiri Wildlife Sanctuary.

We walked 54 km during nights with about 21 'spotlight hours'. A total of five (0.19 animals/spot-hour) Small Travancore Flying Squirrels were sighted in the western slopes of the Makut (Wildlife) and Makut (Reserve Forest) ranges. No animal was sighted in the Srimangala range, adjacent to Makut. The animals were located up to 200 m above msl. Local people were also interviewed for more information on the species. Local people from the western side of these hills in the adjoining state of Kerala reported having sighted this species in their coconut and cashew nut gardens. Since this species raids cashew gardens during the crop season to feed on cashew kernel, it is hunted by the locals, who also eat its meat.

Two species of flying squirrels are described from Peninsular India (Prater 1993): the Small Travancore Flying Squirrel *Petinomys fuscocapillus fuscocapillus* and the Large Brown Flying Squirrel (*Petaurista philippensis*). The Large Brown Flying Squirrel occurs throughout Peninsular India, whereas the Small Travancore Flying Squirrel is believed to be restricted to some parts of the Western Ghats. Kurup (1989) rediscovered the Small Travancore Flying Squirrel in coconut groves in coastal Kerala, after a gap of 70 years. Ashraf *et al.* (1993) conducted a survey of flying squirrels in the Indira Gandhi Wildlife Sanctuary in Tamil Nadu and Kudremukh National Park in Karnataka. The Small Travancore Flying Squirrel was recorded only from the Indira Gandhi Wildlife Sanctuary. We have also surveyed the rainforests of Sirsi-Honnavara region north of Sharavati river, and found that the species was absent. The ex-hunters and active hunters also reported that the species was never sighted in the region. Therefore, the sighting of this species in Brahmagiri-Makut is the first report from the forests of Karnataka.

It may be seen from the available literature that this species has only been sighted from three locations so far. To understand its current distribution and status, further surveys are required along the coastal forests and western slopes of the Western Ghats.

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REFERENCES

ASHRAF, N.V.K., A. KUMAR & A.J.T. JOHNSINGH (1993): On the relative abundance of two sympatric squirrels of Western Ghats, India. *J. Bombay Nat. Hist. Soc. 90*: 158-162.

KURUP, G.U. (1989): Rediscovery of the small Travancore flying squirrel. *Oryx 23*: 2-3.

PRATER, S.H. (1993): The Book of Indian Animals, 4th impression. Bombay Natural History Society. Bombay.

4. A CASE OF TOTAL ALBINISM IN THE FIVE-STRIPED PALM SQUIRREL *FUNAMBULUS PENNANTI* WROUGHTON IN SINDHUDURG DISTRICT, MAHARASHTRA STATE

Albinism in wild rodent species is a rare occurrence, though it has been reported in some cases such as *Cremnomys blanfordi* (Rajagopalan 1967), *Bandicota indica*, *Rattus rattus* (Pradhan 1975) and *Funambulus pennanti* (Chaturvedi and Ghose 1984). Harrison (1950) has also dealt with albinism as well as melanism in rodent species. Apart from albinism, Pradhan (1975, 1993) and Bhat (1979) have reported occurrence of white patches on thoracic and inguinal regions in the species of *Rattus*, *Bandicota*, *Mus* and *Golunda*. Pradhan and Mithel (1981) indicated possible genetic control for occurrence of white patch in *Rattus rattus rufescens*.

Albinism in Five-striped palm squirrel has been reported from the erstwhile Oudh, Uttar Pradesh (Agrawal and Chakraborty 1979) and Chandigarh (Chaturvedi and Ghose 1984) in India. Since then, no specific report of albinism in this Indian rodent species is available. In November 2001, a team from the Zoological Survey of India, Pune visited different areas of Sindhudurg district, Maharashtra State, to conduct a status survey on the Indian Edible-nest Swiftlet *Collocalia unicolor* (Jerdon). The team came across a live albino form of a squirrel species. Observing through a pair of 7 x 50 binoculars, we noticed that the individual was white with faint red spots, narrow stripes on the flanks, pink eyes and yellowish forehead. Two species of striped squirrels have been reported from this region (Ellerman 1961): 1. Three-striped Jungle Squirrel *Funambulus tristriatus* with three stripes and a distinct red colouration in the inguinal region and on the ventral side of the tail and 2. Five-striped Palm Squirrel *Funambulus pennanti* with five stripes and no red colouration in the inguinal region and below the tail. The *F. pennanti* specimen studied by Chaturvedi and Ghose (1984) from Chandigarh was a spotless white. One of us (MSP) identified the live albino squirrel, photographed near Deogad Fort, as *Funambulus pennanti* Wroughton (Photographic evidence provided by the authors – Eds). The squirrel was seen moving on a rocky wall of the fort in the morning hours of November 22, 2001. Deogad Fort (16° 23' N, 73° 21' E) is situated very close to the Arabian Sea in the Deogad taluka, Sindhudurg district, Maharashtra State.

After a while, AM and RMS spotted a solitary albino young (hardly a foot away from where the adult was first sighted), which quickly moved into the nesting site, in an inaccessible rocky crevice, depriving us of a photographic opportunity. Further attempts to locate both the individuals were futile. Hutt (1969) considered albinism as an indication of infertility. However, in the present case, sighting of an albino young with an albino adult indicates the likelihood of a naturally breeding albino population of *F. pennanti* in the wild.

The present report of albinism in *F. pennanti* is probably the third from India. Albinism is known to occur when the genes for pigmentation fail to be expressed, and its occurrence in the wild is rare.

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REFERENCES

AGRAWAL, V.C. & CHAKRABORTY (1979): Catalogue of Mammals in the Zoological Survey of India. Rodentia Part I. Sciuridae. *Rec. zool. Surv. India 74(4)*: 333-481.

BHAT, SUDHA (1979): Studies on Bombay rats. Ph.D. Thesis, Bombay University, Bombay.

CHATURVEDI, Y. & A.K. GHOSE (1984): A case of albinism in the five

striped palm squirrel, *Funambulus pennanti* Wroughton. *Bull. Zool. Surv. India 6(1-3)*: 321-322.

ELLERMAN, J.R. (1961): The Fauna of British India. Mammalia Vol. 3. Rodentia Part 1. Govt. of India Press, New Delhi.

HARRISON, J.L. (1950): The occurrence of albino and melanic rats. *J. Bombay Nat. Hist. Soc. 49(3)*: 548.

HUTT, F.B. (1969): Genetic aspects of infertility. *In*: Comparative mammalian Cytogenetics (Ed. Benirschke, K.). Springer-Verlag, New York.

PRADHAN, M.S. (1975): Studies on Bombay Rats. Ph.D. Thesis, Bombay University, Bombay.

PRADHAN, M.S. (1993): Rodent from Nasik District, Maharashtra State. *Rodent Newsletter 17(3-4)*: 1-2.

PRADHAN, M.S. & M. MITHEL (1981): White patch and its genetic control in some of the Indian rodent species. *J. Bombay Nat. Hist. Soc. 78(1)*: 164-165.

RAJGOPALAN, P.K. (1967): A case of albinism in *Rattus blanfordi* (Thomas) 1881, (Rodentia: Muridae). *J. Bombay Nat. Hist. Soc. 64(3)*: 554.

5. OCCURRENCE OF LITTLE CORMORANT *PHALACROCORAX NIGER* IN LADAKH

On the afternoon of August 18, 2002 between 1330-1340 hours, an adult Little Cormorant *Phalacrocorax niger* was observed in the Indus river near Mahe (33° 05' N and 78° 02' E) in Ladakh, far to the north of its hitherto known range in the Indian subcontinent. The bird was immediately identified as Little Cormorant, a species familiar to the observers. The individual was observed repeatedly diving for fish in the murky water of the swollen river.

Ali and Ripley (1981), Grimmett *et al.* (1998) and Kazmierczak and van Perlo (2000) do not mention Ladakh in the species distribution. As far as we are aware, there are no previous records of the Little Cormorant from Ladakh except one recent sighting from Shey fish tanks near Leh where two birds were sighted in the summer of 2001 (Otto Pfister *pers. comm.*)

We thank Otto Pfister for providing us the recent sight record.

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REFERENCES

ALI, S. & S.D. RIPLEY (1981): Handbook of the Birds of India and Pakistan. Vol. 1, 2nd Edn. Oxford University Press, Delhi. Pp. 41-42.

GRIMMETT, R., C. INSKIPP & T. INSKIPP (1998): Birds of the Indian Subcontinent. Christopher Helm, London. Pp. 557.

KAZMIERCZAK, K. & B. VAN PERLO (2000): A Field Guide to the Birds of the Indian Subcontinent. Pica Press, Robertsbridge, U.K. Pp. 41-42.

6. AN INSTANCE OF MORTALITY AND NOTES ON BEHAVIOUR OF BLACK-NECKED STORKS *EPHIPPIORHYNCHUS ASIATICUS*

The Black-necked Stork *Ephippiorhynchus asiaticus* is one of the least studied large water birds in India and very little is known of their ecology (Rahmani 1989). During fieldwork in Etawah and Mainpuri districts, Uttar Pradesh between September 1999 and July 2002, I maintained detailed records of all sightings of Black-necked Storks. In this note, an instance of adult mortality and some interesting behaviours are documented. Fieldwork was carried out in an area of *c.* 500 sq. km, within the towns of Etawah, Karhal, Kishni and Baralokpur.

Mortality

In December 1999, an adult male Black-necked Stork was found dead below electric lines at Saiphai (26° 57.063' N, 78° 57.518' E). The body had been in water for three to four days when discovered and it was not possible to ascertain whether the bird had been killed by collision or electrocution with the wire. The stork had been seen to roost alone in an adjoining field regularly and was most likely killed while returning to the roost or flying from it to a wetland across the road, where it used to feed during the day. The prevalence of morning and evening fog during December in the area must have led to the mortality. From interviews with villagers it appeared that storks die infrequently in the area due to collision with electric lines.

While electrocution/ collision with electric wires of large-bodied water birds is widespread in occurrence, it has not been previously reported for Black-necked Storks, and in Ciconiidae, collision-related mortality has been previously recorded only for the White Stork *Ciconia ciconia* (Bevanger 1998). In fact, there is no reference in literature to any form of adult mortality in Black-necked Storks. However, the

contribution of mortality due to electrocution / collision with electric wires in the apparent decline in numbers of the species is minimal and the phenomenon is a rarity.

Behaviour

Vocalization

Though frequently claimed to be voiceless as adults, storks are capable of producing a large number of vocalizations (Table 1). All species of storks are also known to bill-clatter as adults and young birds, with the exception of the Saddlebill Stork *E. senegalensis*, which seems to be genuinely silent after fledging (Elliott 1992). Black-necked Storks are known to call only as downy nestlings, and regarded to be largely silent away from the nest (Ali and Ripley 1989, Grimmett *et al.* 1998).

I observed vocalization in a Black-necked Stork juvenile aged five to six months. A family of five Black-necked Storks (two adults and three juveniles were observed foraging along with a family of Sarus Cranes *Grus antigone* (two adults, one sub-adult) in an inundated agriculture field in Etawah, near Saiphai town (26° 59.238' N; 78° 58.377' E, April 30, 2000, 1815 hrs). One of the juveniles was observed calling, *peeeeeu-peeeeu-peeeu-peeu-piu-piuu-piuu* emitted as a low, mildly warbling, high pitched whistle, starting at a much higher pitch than the ending. The "*eu*" portion of the call was less pronounced at the beginning of the call and increased gradually and continuously. The call consisted of 10-12 notes, followed by a very short pause, and commenced again. The call had a curious ventriloquist quality, and required concentration to determine the source, especially since the juvenile stork gave no discernable movement attributable to the call. The juvenile Black-necked Stork had its body held horizontally to the ground, wings folded, neck bent, and bill slightly open while calling (Fig. la). The adult male responded to the call by walking towards the young bird, head slightly tilted to the ground. The young bird maintained the posture and walked away, but the intensity and pitch of the call increased. The approach was thought to be antagonistic. This happened twice during the entire observation, which lasted over 30 minutes. During the second approach by the male, the call was initiated at a very high pitch *tchiiiu*, which then continued into the call described above. The female and the other juveniles were unperturbed by the calling. It is thought that the call was an attempt at solicitation.

Table 1: Vocalization in Storks

Stork Genera/Species	Volicalization	
	Adult	Young
Anastomus	Honk, croak[1]	-
A. oscitans	Occasional deep moans[2]	-
Ciconia	Whistles[1]	-
C. ciconia	Poorly developed[2]	-
C. episcopus	Silent[2]	-
C. nigra	Guttural notes described as 'melodious'[2]	(Nestlings) Heron-like chatter[2]
Ephippiorhynchus asiaticus	Largely silent away from the nest[3]	(Downy nestlings) *Chaek* followed by *wee-wee-wee*[2]
E. senegalensis	-	Weak vocalizations at nest[3]
Jabiru mycteria	Gasping, coughing sounds during copulation[4]	-
Leptopilos	Squeal, moo[1]	-
L. crumeniferus	Moo, whine, whistle, hiccup[1]	Chitter, squawk, bray[1]
Mycteria	Hiss, fizz[1]	-
M. leucocephala	Low moan at nest[2]	(Half-grown nestlings) Harsh grating or scraping noise.[2]

1 - Elliott 1992; 2 - Ali & Ripley 1989; 3 - Grimmett *et al.* 1998; 4 - Kahl 1973

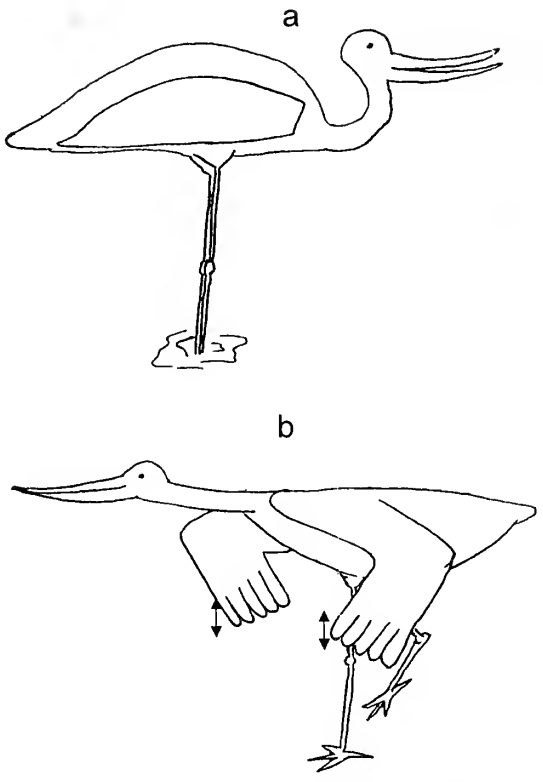

Fig. 1: a. Posture of young bird during vocalization
b. "Solicitation Display" of young bird

Kahl (1973), commenting on the vocalizations of stork nestlings, feels that soft vocalizations are sufficient for communication in *Ephippiorhynchus* and *Jabiru* storks since the members of these two genera are solitary nesters and the young are not required to drown out the calls of nestlings of adjoining nests. He also feels that the low voice of nestlings of solitary nesters has evolved to minimize nest detection by predators. Calling has been documented once before when a juvenile was observed "peeping continuously" in Bharatpur's Keoladeo National Park (KNP) and the authors also think that the young bird was soliciting food (Breeden and Breeden 1982).

Solicitation display

Another behaviour observed is thought to be a non-vocal form of solicitation, which a juvenile Black-necked Stork was observed displaying to an adult male. Both birds were standing on a metalled road, 7 km from Karhal town (27° 390' N; 97° 724' E, March 30, 2000, 0815 hrs). The juvenile held the body and the outstretched neck parallel to the ground; the wings were open and held in line with the body, but bent at the elbows (Fig. 1b). The juvenile quivered its wings continuously while walking towards the adult. The beak was intermittently opened. This position (Fig. 1b) was held for almost three minutes, after which the bird assumed an alert posture ('Anxiety Stretch', Kahl 1973), and then began preening. The quivering stopped when the adult stork walked away from the approaching juvenile. Vocalizations could have been prevalent during this observation, as indicated by the opening of the bill, but the observations were done from over 200 m and the vocalizations could not be discerned. A very similar behaviour has been noted in Saddlebill Storks where a nestling was seen to "bend forward with body axis nearly horizontal, wings slightly lifted and spread at wrist, tail cocked *c.* 20° above line of back; giving rhythmic 'yes' nods of head with bill gaped open; weak vocalizations accompanied upward movement of head" (Kahl 1973: 25). This behaviour has been termed 'Begging Display' and has been seen to be a ritualized social behaviour that the young performs every time the adult arrives at the nest.

For the new behaviour described above and illustrated in Fig. lb, I suggest the name Solicitation Display, which differs from Begging Display in that it is performed by juveniles which have fledged, and is thus always performed away from the nest. Also, while the Begging Display is performed every time the adult comes into the nest, Solicitation Displays would be performed only when the juvenile is in close proximity with an adult and is unable to acquire food. In March, most of the wetlands in the study area reduce drastically in size, and it is possible that this display is performed only during the dry months when the food supply is low. Breeden and Breeden (1982) have recorded a similar behaviour accompanied by peeping in KNP during a drought, corroborating my surmise that this behaviour is carried out only in extreme situations.

Kahl (1973) suggested that the Black-necked Stork (which was then *Xenorhynchus asiaticus*) and the Saddlebill Stork be combined under one genus *Ephippiorhynchus*, due to their resemblance in several aspects of behaviour and morphology [see also Wood (1984) for further discussion]. The two above-mentioned observations corroborate the semblance in behaviour of the two species, lending further evidence for the phylogenetic similarity proposed by Kahl (1973) and Wood (1984).

Up-down display

Another rare behaviour observed was the courtship display of the adults, the Up-Down display (*sensu* Kahl 1973). This behaviour is supposed to help in strengthening the pair bond between adults. Though usually performed at the nest during the breeding season, the behaviour was seen being performed in a damp patch of grassland next to a main road, in April 2000. The flapping of the wings vertically was accompanied with bill clattering and the display lasted for less than ten seconds. Subsequently, the birds resumed foraging. In spite of nearly a thousand sightings of Black-necked Storks over the entire study period, this display was observed only once; it is definitely performed very rarely. The observation was in April, which suggests that the behaviour may be performed by pairs throughout the year, though it is possible that the frequency increases prior to or during the breeding season as opined by Kahl (1973).

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REFERENCES

Ali, S. & S.D. Ripley (1989): Handbook of the Birds of India and Pakistan. Vol. 1. Divers to Hawks. Oxford University Press, Bombay. Pp 93-103.

Bevanger, K. (1998): Biological and conservation aspects of bird mortality caused by electricity power lines: a review. *Biol. Conserv. 86*: 67-76.

Breeden, S. & B. Breeden (1982): The drought of 1979-1980 at the Keoladeo Ghana Sanctuary, Bharatpur, Rajasthan. *J. Bombay Nat. Hist. Soc. 79*: 1-37.

Elliott, A. (1992): Family Ciconiidae (Storks). Pp. 441-442. *In*: Handbook of the Birds of the World. Vol 1. (Eds: del Hoyo, J., A. Elliott & J. Sargatal). Lynx Edicions, Barcelona.

Grimmett, R., C. Inskipp & T. Inskipp (1998): Birds of the Indian Subcontinent. Oxford University Press, New Delhi. Pp. 573-574.

Kahl, M.P. (1973): Comparative ethology of the Ciconiidae. Part 6. The Black-necked, Saddlebill, and Jabiru Storks (Genera *Xenorhynchus, Ephippiorhynchus* and *Jabiru*). *The Condor 75*: 17-27.

Rahmani, A.R. (1989): Status of the Black-necked Stork *Ephippiorhynchus asiaticus* in the Indian subcontinent. *Forktail 5*: 99-110.

Wood, D.S. (1984): Concordance between classifications of the Ciconiidae based on behavioural and morphological data. *J. Orn. 125*: 25-37.

7. RED-CRESTED POCHARD — *RHODONESSA RUFINA* (PALLAS) IN KACHCHH

Though a winter visitor to Pakistan and northwest India, including the Saurashtra region of Gujarat, the Red-crested Pochard *Rhodonessa rufina* (Pallas), as far as we know, has not been seen in Kachchh. Dr. Sálim Ali's survey of Kachchh in 1943-44 failed to observe it. The earlier published lists of Dr. Ferdinand Stoliczka and A.C. Hume do not include *Rhodonessa rufina* in Kachchh. Ali and Ripley (1968) mention that this diving duck is common and locally abundant, particularly in Pakistan and northwest India. Roberts (1991) says that it has a limited breeding range in 'warmer steppic latitudes in central Asia and Turkestan. It is a winter migrant visitor to Pakistan which has now become rather rare.'

We had gone to Mandvi taluka on January 19, 2003 for our annual Asian mid-winter waterbird census. On our way to one of the count sites, we stopped at the tank of Don village, where a fair number of ducks were present. While we watched the ducks through our binoculars we noticed a pair of *Rhodonessa rufina* amongst them. The drake was unmistakable with his handsome plumage and red bill, and it did not take long to identify the duck swimming beside him. AP photographed the drake. We showed the photo to M.K. Himmatsinhji, our mentor, who confirmed the identification and advised us to inform the Society, hence this note.

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REFERENCES

Ali, Sálim & S.D. Ripley (1968): Handbook of the Birds of India and Pakistan, Vol. 1, Oxford University Press, Bombay.

Roberts, T.J. (1991): The Birds of Pakistan, Vol. 1, Oxford University Press, Karachi.

8. PREDATION BY MARSH HARRIER *CIRCUS AERUGINOSUS* ON CHICK OF SARUS CRANE *GRUS ANTIGONE ANTIGONE* IN KOTA, RAJASTHAN

The Sarus Crane *Grus antigone antigone* is a threatened species found largely in north and central India. It is a large-bird species that has suffered a rapid population decline in recent times as a result of widespread reduction in the extent and quality of wetland habitats that are being converted to agriculture fields (BirdLife International 2001, Sundar *et al.* 2000).

Few ecological studies on Sarus Cranes have examined in detail the various aspects of its breeding biology, nest-site requirements and existing threats to breeding sites, as also the causes of chick mortality.

Breeding biology of the Sarus Crane was studied in the semi-arid landscape of Kota and Bharatpur districts of Rajasthan from February 2000 to June 2002. Data on number

of eggs laid, egg-loss, number of hatchlings and hatchling mortality was recorded. The nests were monitored till the time the chicks reached juvenile stage and subsequently weaning success was calculated. Six Sarus Crane families were chosen and intensively monitored till the hatchling reached the weaned stage. It was found that fledgling success was affected both by natural causes such as predation, wetness of nesting site, food availability, as well as by anthropogenic causes such as egg robbing and prevalent agricultural practices. Mortality of Sarus Crane recorded in the study area for two consecutive years has been shown in Table 1.

Table 1: Mortality of Sarus Crane young in Kota district (2000-2001)

Year	Total no. of chicks hatched	Reasons for Mortality			
		Dog	Marsh Harrier	Human-related	Unknown
2000	17	2	0	1	12
2001	34	0	1	0	16

The chosen focal-families were also examined for parent-chick interactions using the scan sampling method. During the course of these observations on one of the focal families, consisting of two chicks 40 and 39 days old, an incident of chick predation was noted. While the parents were feeding one of the chicks, the second chick which was feeding alone 25-30 m away from the parents, was left unattended for a brief period. A Marsh Harrier attacked this chick and repeatedly pecked its head, causing severe injury, but flew away without feeding on the chick. Although the harrier was clearly preying upon on the chick, the reason for abandoning the prey is not clear. The injured chick died within two hours and the parent birds left the feeding area and moved away.

Predators previously recorded for Sarus Crane chicks include jackals (Walkinshaw 1973; Ramachandran and Vijayan 1994) and dogs (Mukherjee and Borad, *pers. obs.*). Although an observation of a male Sarus Crane calling loudly and chasing a Marsh Harrier from its nesting territory has been recorded previously, indicating the possibility of chick predation by large raptors (Iqubal 1992; Mukherjee *et al.* 2002), the present study confirms and records predation by Marsh Harrier.

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REFERENCES

BirdLife International (2001): Threatened Birds of Asia: The BirdLife International Red Data Book. BirdLife International, Cambridge, U.K.

Iqubal, P. (1992): Breeding behaviour in Sarus Crane *Grus antigone antigone*. M.Sc. Thesis, Aligarh Muslim University, Aligarh, India.

Mukherjee, A., C.K. Borad & B.M. Parasharya (2002): Breeding performance of the Indian Sarus Crane in the agricultural landscape of western India. *Biological Conservation 105*: 263-269.

Ramachandran, N.K. & V.S. Vijayan (1994): Distribution and general ecology of the Sarus Crane (*Grus antigone*) in Keoladeo National Park, Bharatpur, Rajasthan. *J. Bombay Nat. Hist. Soc. 91(2)*: 211-223.

Sundar, K.S.G., J. Kaur & B.C. Choudhury (2000): Distribution, demography and conservation status of the Indian Sarus Crane (*Grus antigone antigone*) in India. *J. Bombay Nat. Hist. Soc. 97(3)*: 319-339.

Walkinshaw, L.H. (1973): Cranes of the world. Winchester Press. New York.

9. THE LESSER KESTREL *FALCO NAUMANNI* AND AMUR FALCON *FALCO AMURENSIS* IN THE GARO HILLS, MEGHALAYA, INDIA

Both the Lesser Kestrel *Falco naumanni* and Amur Falcon *F. amurensis* are mainly passage migrants to India. The Amur Falcon, which migrates in countless swarms in autumn, is also a scarce breeder in north-eastern India (Baker 1928; Samant *et al.* 1995). Both species are often seen together and migrate on a broad front, with confirmed sightings throughout many areas in the Indian subcontinent. Visual records are mainly between October and early-January, but little is known of this large-scale migration involving thousands of birds. The weather pattern that triggers these migrations is also not known. Ali and Ripley (1978) had collated all available records till 1970. With the upsurge of interest in

bird watching and ornithology, additional sightings have recently been recorded from Wynaad, Kerala (Zacharias and Gaston 1993); Sri Lanka (Hoffmann 1996); Corbett Tiger Reserve, Uttaranchal (Naoroji 1999); Kaziranga National Park, Assam (Barua and Sharma 1999); Dera Ismail Khan, NW Pakistan (Kylanpaa 2000); Mysore, Karnataka (Thejaswi *et al.* 2004). It is important to record all these observations for a composite, overall picture of this migration and stop-overs throughout the Indian subcontinent. Prey availability also affects stop-over schedules. Therefore food and feeding behaviour is also described.

Our aim in visiting Meghalaya was to observe the migration of the Amur Falcon and Lesser Kestrel. The main passage period of Amur Falcon in the Northeast is end October when thousands pass through (Baker 1928). In 2000, the first author (RN) had observed only the Lesser Kestrel in and around Balphakram National Park: December 26, 2000, more than 10 birds at Durpeta between 1600-1700 hrs; December 28, 2000 at 1640 hrs, 30 birds wheeling above a harvested slope near Durpeta; December 29, 2000, more than 15 in the morning, 3 km from New Rompa Inspection Bungalow. The same day, four individuals were seen on Bagmara / Tura highway just before Hiringiri village at 1300 hrs.

In 2001, we missed the peak passage spectacle in October. However, at 1500 hrs on November 11, en route to Tura from Guwahati on an overcast day with intermittent heavy drizzle, we observed at least 15 Lesser Kestrel. At 1540 hrs, just before the bifurcation to William Nagar (15 to 20 km before Tura), we observed a large flock of Amur Falcons, estimated between 400 and 800. The falcons milled around, flying in one direction, milling and then streaming off in another direction, throughout uttering high-pitched whistles '*chichek*'. As we neared Tura at dusk around 1600 hrs, an extension of the main flock was observed.

In the South Garo hills from New Rompa (Balphakram National Park headquarters) to Mahesh Khola, from November 11-17, 2001, we occasionally saw a few individuals of the Lesser Kestrel along the road at dusk, feeding on insects.

On November 16, 2001 along the New Rompa / Rongra road, community feeding was observed amongst Lesser Kestrel, Amur Falcon and other bird species. At 1610 hrs about 50 Jungle Crows *Corvus macrorhynchos* were seen feeding on a swarm of emerging winged termites, soon joined by 2 Common Kestrel *Falco tinnunculus*, 1 Lesser Kestrel, 20+ Amur Falcons (including adult males), later joined by 3 Brahminy Kites *Haliastur indus*, 4-5 Ashy Wood Swallows *Artamus fuscus*, 1 Common Hill Myna *Gracula religiosa*, 3 Ashy Drongos *Dicrurus leucophaeus*, 7-8 Spangled Drongos *Dicrurus hottentottus*, 4-5 Asian Palm Swifts *Cypsiurus balasiensis* and Indian Roller *Coracias benghalensis*. By 1620 hrs, the termites disappeared and the feeding stopped. On November 17, 2001 at 1640 hrs at Gasuapara (on the Balphakram/Tura highway), 2 Amur Falcons were observed community feeding on winged termites.

Both species, especially the Amur Falcon, possibly perform the most remarkable migration known in any bird of prey: a total distance of approximately 10,000 to 11,000 km (Brown and Amadon 1968; Ferguson-Lees and Christie 2001). Their long distance migration is from East Asia and in the case of the Amur Falcon to the northern extremity of South Africa, apparently crossing 3,000 km over the Indian Ocean, returning via East Africa and across southern areas of the Asian continent (Ferguson-Lees and Christie 2001). Little is known about this migration through the Indian subcontinent, especially the sea crossing. More information is required on the main passage period and fluctuations of dates depending on weather. It would be interesting to monitor the migration of these two species as and when a lightweight satellite transmitter is developed, which should be no more than 4 percent of the falcon's weight. Even rough estimates of numbers and locations recorded throughout the Indian subcontinent will, over time, indicate the extent of the passage and routes taken.

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REFERENCES

ALI, S. & S.D. RIPLEY (1978): Handbook of the Birds of India and Pakistan together with those of Bangladesh, Nepal, Bhutan and Sri Lanka, 2nd Edn. Vol. 1. Oxford University Press, Delhi.

BAKER, E.C.S. (1928): The Fauna of British India including Ceylon and Burma, 2nd Edn. Vol. 5. Taylor & Francis, London.

BARUA, M. & P. SHARMA (1999): Birds of Kaziranga National Park, India. *Forktail 15*: 47-60.

BROWN, L.H. & D. AMADON (1968): Eagles, Hawks & Falcons of the World. Vol. 1 & 2. Country Life Books, London.

FERGUSON-LEES, J. & D.A. CHRISTIE (2001): Raptors of the World. Christopher Helm Ltd, London.

HOFFMANN, T.W. (1996): New bird records in Sri Lanka and some connected matters. *J. Bombay Nat. Hist. Soc. 93(3)*: 382-388.

KYLANPAA, J. (2000): Birds of Dera Ismail Khan District of North West Frontier Province in Pakistan. *Forktail 16*: 15-28.

NAOROJI, R.K. (1999): Status of Diurnal Raptors of Corbett National Park with Notes on their Ecology and Conservation. *J. Bombay Nat. Hist. Soc. 96(3)*: 387-398.

SAMANT, J.S., V. PRAKASH & R.K. NAOROJI (1995): Ecology and Behaviour of resident raptors with special reference to endangered species, Final Technical Report 1990-93. Bombay Natural History Society, Bombay.

THEJASWI, S., S. SASTRY, A. SHIVPRAKASH &M. MOHAN KUMAR (2004): Occurrence of Amur Falcon *Falco amurensis* Radde and Lesser Kestrel *Falco naumanni* Fleischer in Mysore, Karnataka. *J. Bombay Nat. Hist. Soc. 101(3)*: 451-452.

ZACHARIAS, V.J. & A.J. GASTON (1993): The Birds of Wynaad, Southern India. *Forktail 8*: 11-23.

10. THE DIET OF THE NICOBAR MEGAPODE *MEGAPODIUS NICOBARIENSIS*, IN GREAT NICOBAR ISLAND

The Nicobar Megapode *Megapodius nicobariensis*, a mound nesting bird, is endemic to Nicobar Islands. Megapodes are a unique group of birds as they utilise external sources of heat to incubate their eggs (Jones *et al.* 1995). They forage by scratching and raking the debris on the ground (Jones *et al.* 1995). Different types of food items have been reported, including both plant and animal matter (Cleland 1912; Booth 1986). Leaf-litter invertebrates and seeds are the major food items of megapodes (Gill 1970; Brookes 1919), but in captivity they consume mice, tadpoles and snails (Coles 1937). Stomach contents of a Nicobar Megapode specimen from Tillanchong contained a beetle *Scarabus plicatus* and a snail *Helicina zelebori* (Ali and Ripley 1983). Detailed information on the diet of the mound building Nicobar Megapode has not been published so far. Hence, the diet of a population of the Nicobar Megapode *Megapodius nicobariensis* at the Great Nicobar Island was studied.

This study was carried out from December 1995 to May 1998 at the southern tip of the Great Nicobar I. (6° 76' to 6° 79' N, 93° 81' to 93° 84' E). The study area was a narrow strip of forest, between 40 and 300 m wide, bound by the beach to the east and by wetlands or forests to the west. The foraging megapodes were intensively observed from hides constructed at four different places, following focal animal sampling (Altmann 1974). Apart from this, the diet of the Nicobar Megapode was analysed from gut samples of three dead specimens that were acquired from tribals. The gut contents were identified and then grouped. The stomach contents of two dead chicks were also examined.

A plastic tube of 4 mm diameter, attached to a 500 ml plastic bottle filled with saline, was moistened with saline solution for lubrication and inserted into the mouth of the bird. The bird was then inverted over a plastic cup, so that as the fluid was forced into its stomach, the excess fluid plus the stomach contents flowed into the cup (Hess 1997). Five megapode stomachs were flushed by this method. After the flushing, the birds were seen resuming their activities without any abnormal behaviour, showing that this method was not stressful to the birds. The preference rank of each food item consumed by the Nicobar Megapode was arrived at by both the Volumetric and Occurrence Method (Kennedy and Fitzmaurize 1972).

The Nicobar Megapode was observed eating soil invertebrates, flying insects and vegetable matter. The stomach contents reveal that the primary food items of the Nicobar Megapode were cockroaches, beetles, ants, lizards, snails, grasshoppers, hermit crabs, seeds of *Macaranga peltata* and rotten vegetable matter. One bird was observed chasing an agamid lizard on the ground. Megapodes have also been observed feeding on the tissue of dead red crabs.

Seeds of *Macaranga peltata* dominated among the stomach contents of this species (Table 1). Cockroaches and snails were the major animal food items. Some beetles in the megapode diet were *Anomala andamanica*, *A. rhodomela*, *A. varicolor*, *Alissonotum piceum*, *Parastasia luteola*, *Heteronechus liioderes*, *Rhyssemus germanus*, *Aphodius moestus*, *Holotrichia nicobarica*, *Apogonia nicobarica*, and *Dasyvalgus insularis*. These megapodes were also seen consuming centipedes, lepidopterans, termites and tadpoles. Like many other birds, they ingested grit in order to help break down their food. They were occasionally observed drinking rainwater. Of the stomachs of the two dead chicks that were analyzed, one chick, which was partially eaten by a hermit crab, contained only the seeds of *Macaranga peltata* in its stomach. Another chick that was most likely attacked by a raptor, contained nothing in its stomach.

Table 1: The diet and its preference by the Nicobar Megapode

Food item	Rank based on Volumetric proportion	Rank based on frequency of occurrence
Macaranga peltata	1	1
Dictyoptera (cockroaches)	2	2
Snails	2	3
Litters	3	2
Beetles	4	4
Ants	4	4
Unidentified	4	3
Grasshopper	4	5
Pauropodans	5	5
Hermit crab	5	5
Reptile scale	6	6

Like other megapodes, the Nicobar Megapode also forages by scratching and raking the debris on the ground. More precipitation reduced the foraging activities of the Nicobar Megapode (Spearman correlation test: r_s= -0.46, p= 0.05). Foraging patterns varied significantly between the years (Kruskal Wallis test: H= 9.23, df= 2, p<0.01), due to significant variation in precipitation (Kruskal Wallis test, H= 7.81, df= 2, p= 0.02). The data reported here agreed with other reports for the genus *Megapodius*: that they are omnivorous (Jones *et al.* 1995).

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REFERENCES

Ali, S. & S.D. Ripley (1983): Handbook of the Birds of India and Pakistan. Compact edition. Oxford University Press, Bombay. 737 pp.

Altmann, J. (1974): Observational study of behaviour: sampling methods. *Behaviour 48*: 227-265.

Booth, D. T. (1986): Crop and gizzard contents of two Mallee fowl. *Emu 86*: 51-53.

Brookes, G.B. (1919): Report on investigations in regard to the spread of prickly pear by the Scrub Turkey. *Queensland Agricultural Journal 11*: 26-28.

Cleland, J.B. (1912): Examination of contents of stomachs and crops of Australian birds. *Emu 12*: 8-18.

Coles, C. (1937): Some observations on the habits of the Brush Turkey (*Alectura lathami*). *Proceedings of the Zoological Society of London 107(A)*: 261-73.

Gill, H.B. (1970): Birds of Innisfail and hinterland. *Emu 70*: 105-116.

Hess, H.C. (1997): Stomach flushing: sampling the diet of Red-cockaded Woodpecker. *Wilson. Bull. 109(3)*: 535-539.

Jones, D.N., R.W.R.J. Dekker & C.S. Roselaar (1995): The Megapodes. Oxford University Press. 262 pp.

Kennedy, M & P. Fitzmaurize (1972): Some aspects of the biology of gudgeon *Gobio gobio* (L.) in Irish waters. *J. Fish. Biol. 4*: 425-440.

11. GRIT USE IN THE SARUS CRANE *GRUS ANTIGONE*

Introduction

Grit is generally ingested by granivorous and herbivorous birds, and to a smaller extent by insectivorous birds (Weltry and Baptista 1988). The main purpose of grit intake by birds is to facilitate the mechanical grinding in the gizzard of any hard, coarse material ingested by the bird. However, grit may also provide calcium to female birds just before the breeding period (Harper 1964). Grit use patterns are fairly well understood for Galliformes (Dalke 1937; Sadler 1961) and for 'cornfield birds' (Best and Gionfriddo 1991; Gionfriddo and Best 1996). While several observations have been made towards ingestion of grit particles by Sarus Cranes (J. Langenberg *pers. comm.*, M. Nagendran *pers. comm.*, K.S.Gopi Sundar *pers. obs.*), no information exists on the amount and kind of grit ingested by Sarus Cranes. In this paper, we present information on grit use by the Sarus Crane in India based on contents of three Sarus Crane gizzards.

METHODS

The gizzards of three Sarus Cranes (one each of a sub-adult, male and female bird), which had been collected after their death due to suspected pesticide poisoning (S. Sharma, *pers. comm.*), were obtained from Keoladeo Ghana National Park in Bharatpur, India. The age of these birds were unknown

and could only be inferred from the development of the red colouration on the head (Ali and Ripley 1980). The gizzards were found to contain large amounts of vegetable matter and grit. The gizzards were sliced open, all the contents were flushed onto petri dishes, and the grit separated, washed and dried.

Characterization of grit was done following Best and Gionfriddo (1991). Three measurements used to characterize the grit were: 1) Size - the average of the longest and the shortest dimensions of each particle was calculated by measuring the two dimensions with Vernier callipers to the nearest 0.01 mm. 2) Shape - grit shape index was calculated by dividing the longest dimension with the shortest. The particles representing a spherical shape would have an index of 1.0 and grit with values greater than unity were deemed oval to oblong, and 3) Roundness - grit roundness was measured by classifying all particles in five categories, namely Angular, Sub-angular, Sub-rounded, Rounded and Well-rounded. Roundness index was calculated by giving grit particles a value of 1 for Angular, 2 for Sub-angular and so on; values tending towards five would mean grit with completely smooth surfaces.

Grit particles with the longest dimension <1 mm were excluded from the analysis, assuming that they were accidentally ingested by the cranes, or were broken down from larger particles. Very few particles (<1%) were excluded from the total sample for this reason. All grit particles of each bird were weighed together to the nearest 0.01 gm.

RESULTS

A total of 523 grit particles were counted and measured from the gizzards of the three Sarus Cranes. The total weight, number of grit particles, mean grit size and mean grit shape are indicated in Table 1. Though the male bird had the highest mean grit size, the two largest grit particles (> 10 mm) were found in the other two birds. The largest range of grit sizes was seen in the sub-adult and female bird (Fig. la). Most grit particles (80.7%) in all three gizzards were between 2-6 mm in size (Fig. 1b). While the sub-adult and the female bird had most grit particles in the size range of 2-4 mm, the male bird had most grit particles in the 4-6 mm range (Fig. la). Most of the particles (69%) had a shape index of 1.5-2.5 (Fig. 1b). The male bird had the largest variety of shapes (9 classes) and the female, the least (6 classes). All three birds used most of the grit particles in the shape index range of 1.5-2 (Fig. 1b). The most represented grit roundness categories were Sub-angular and Sub-rounded (77.6% of all particles, Fig. 1c). The least represented roundness category was Well-rounded (n=1) in the entire sample. The largest proportion of Angular particles

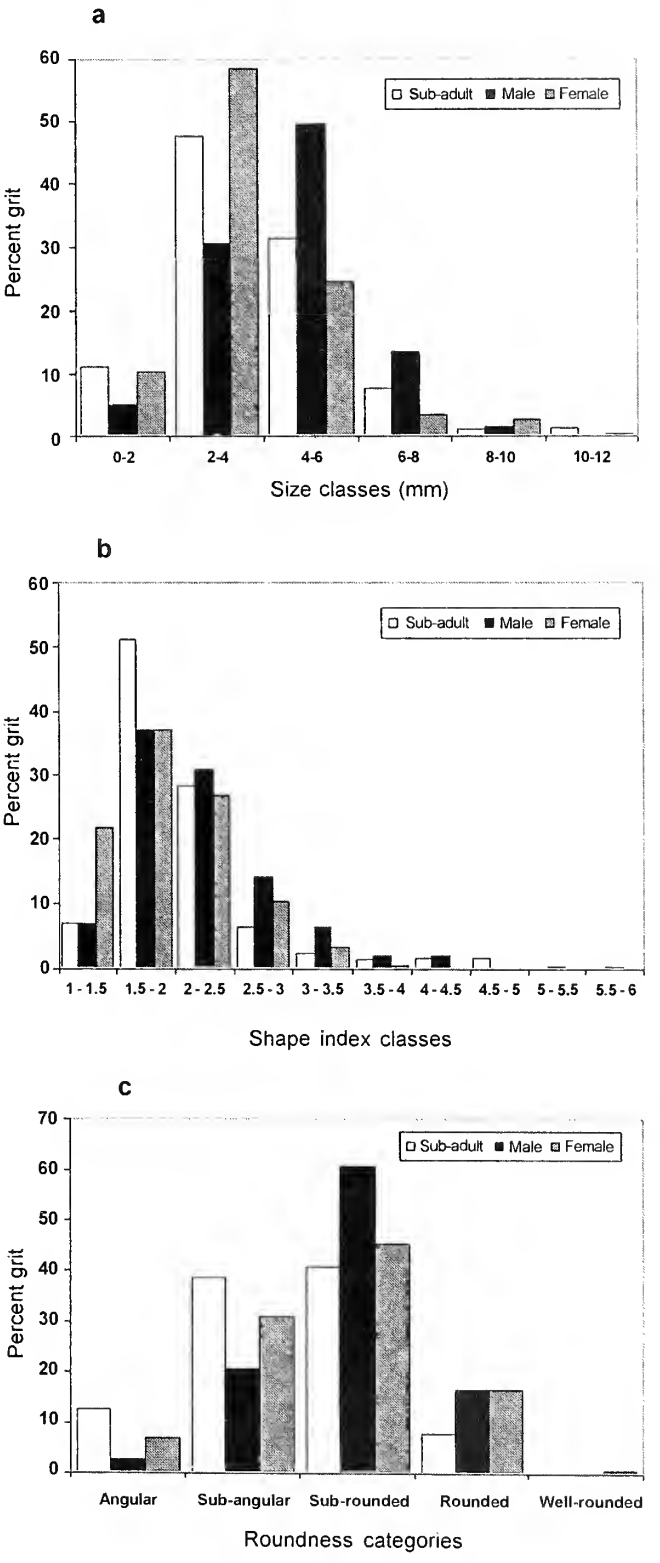

Fig. 1: a. Percent composition of grit particles across different size classes;
b. Percent composition of grit particles across different shape index classes;
c. Percent composition of grit particles across different roundness categories

Table 1: Characteristics of grit in Sarus Cranes

Gizzards sampled	Number of grit particles	Total weight (gm)	Mean size (mm)	Shape index	Mean Roundness
Sub-adult	108	13.46	3.92 (1.1-10.41)	2.01 (1.18-4.55)	2.45
Adult male	220	35.95	4.5 (1.28-8.57)	2.2 (1.11-5.62)	2.94
Adult female	195	22.65	3.68 (1.03-11.8)	1.94 (1.17-3.89)	2.74

Range of mean size and shape index of grit is given in parentheses

was seen in the sub-adult bird. All three birds used most of the grit particles in the Sub-rounded category (Fig. 1c). Mean roundness of grit particles was almost the same in all three birds (Table 1).

DISCUSSION

While use of grit in birds is known to differ with body size, gender, reproductive status and availability, diet is known to be the most important factor influencing use of grit (Gionfriddo and Best 1996). Increase in number of grit particles is usually in bird species with a diet of hard, coarse material, particularly seeds and vegetable matter (Gionfriddo and Best 1996), and in species with a varied, unspecialized diet. The Sarus Crane (*Grus antigone*) in India is known to be omnivorous, its diet including grain of several kind, plant shoots, tubers of aquatic plants, frogs, lizards and other reptiles, grasshoppers and other insects, vegetable matter, fruits, molluscs (Hume and Marshall 1879, Baker 1929, Ghorpade 1975), fish (Law 1930) and occasionally eggs of other birds (Sundar 2000). The omnivorous habit of the species most likely facilitates the intake of such large quantities of grit. Many of the foods reported for the Sarus are calcium-rich, and it is unlikely that grit is ingested to supplement calcium, but primarily fulfils a mechanical function.

Sarus Crane males are larger than females, and sub-adults are considerably smaller than adult birds (Ali and Ripley 1980). This may explain the difference in the higher number of grit particles and the corresponding weight of the gizzard of the male bird, and the smaller values for the other two birds (Table 1). Most of the grit particles used by the male bird were also of a higher size class compared to those in the other two birds (4-6 mm as against 2-4 mm). Larger sample sizes will be required to adequately explore gender and age related differences in grit use patterns in Sarus Cranes.

From this study, it appears that Sarus Cranes generally use grit particles between 2-6 mm in size and opt for grit particles with intermediate degrees of roughness and roundness. In theory, angular particles with sharp edges have the greatest efficiency in digesting coarse food substances, but also pose the risk of damaging internal digestive organs. In contrast, well-rounded particles have the lowest risk with respect to physical injury, but will be least efficient in breaking down food. In this respect, Sarus Cranes seem to be using grit particles to maximize digestion while avoiding excessive physical damage to digestive organs. This data set is useful in that it provides information to aviculturists and zoo managers on the kind of grit that should be provided to captive Sarus Cranes.

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REFERENCES

Ali, S. & S.D. Ripley (1980): Handbook of the Birds of India and Pakistan. Vol 2: Megapodes to Crab Plover. Oxford University Press, Delhi.

Baker, E.C.S. (1929): The game birds of the Indian Empire Vol. V. The waders and other semi-sporting birds. Part VII. *J. Bombay Nat. Hist. Soc. 33*: 4.

Best, L.B. & J.P. Gionfriddo (1991): Characterization of grit use by cornfield birds. *Wilson Bull. 103*: 68-82.

DALKE, P.L. (1937): Food habits of adult pheasants in Michigan based on crop analysis method. *Ecology 18*: 199-213.

GHORPADE, A.M. (1975): Notes on the feeding of the Sarus Crane *Grus antigone antigone* (Linnaeus). *J. Bombay Nat. Hist. Soc. 72*: 199-200.

GIONFRIDDO, J.P. & L.B. BEST (1996): Grit-use patterns in North American birds: the influence of diet, body size, and gender. *Wilson Bull. 108*: 685-696.

HUME, A.O. & C.H.T. MARSHALL (1879): The Game Birds of India, Burma & Ceylon. Vol III. John Bale, London. Pp. 4-5.

HARPER, J.A. (1964): Calcium in grit consumed by hen pheasants in east-central Illinois. *J. Wildl. Manage. 28*: 264-270.

LAW, S.C. (1930): Fish eating habit of the Sarus Crane (*Antigone antigone*). *J. Bombay Nat. Hist. Soc. 34*: 582-583.

SADLER, K. (1961): Grit selectivity by the female pheasant during egg production. *J. Wildl. Manage. 25*: 339-341.

SUNDAR, K.S.G. (2000): Eggs in the diet of the Sarus Crane (*Grus antigone*). *J. Bombay Nat. Hist. Soc. 97*: 428-429.

WELTRY, J.C. & L. BAPTISTA (1988): The Life of Birds. Saunders College Publishers, N.Y.

12. OBSERVATIONS OF MATE CHANGE AND OTHER ASPECTS OF PAIR-BOND IN THE SARUS CRANE *GRUS ANTIGONE*

Sarus Cranes *Grus antigone* are known to be monogamous and pair bond is thought to last throughout the lives of the birds (Ali and Ripley 1989). The male and female of a pair are known to strengthen the pair bond by synchronized behaviours such as duet calls, dance, guard-calls and alarm-calls (Masatomi 1994; Archibald 1976). The actual duration of pair bond, prevalence of mate change and factors leading to such changes are unknown in Sarus Cranes. In this note, I report the first evidence of divorce or separation in Sarus Cranes with observations on other aspects of pair bond and territoriality.

Over two hundred and fifty breeding, territorial pairs of Sarus Cranes were monitored between December 1999-July 2002 as part of a study on their biology and conservation in the districts of Etawah and Mainpuri in Uttar Pradesh. The study area has the highest known density of territorial pairs and number of Sarus Cranes anywhere in the world. Pairs/ families were recognized by colour-banding the juveniles each year, with individual physical marks on adult birds, or by location. Pairs, particularly those with young, were observed one to seven times a week (average of four observations) to collect data on breeding success, feeding habits, territory size, and activity budgets. Mate change was observed in two instances and is discussed in this note. "Divorce" or change of pair membership was actually observed in one pair, while mate change could be deduced in another. In addition, other relevant aspects of pair bonding, territoriality, and related behaviours observed are described and discussed. The behaviour terminology used throughout the text follows Ellis *et al.* (1998).

Mate change observation 1

The territory of one pair was very close to the town of Etawah, and consisted of a large *Typha*-bordered marshland and crop fields. The pair had successfully raised one chick during the breeding season in 1999-2000, and was seen to defend the territory from other Sarus pairs and groups throughout the observation period. In early August, the adult birds were observed to chase the sub-adult from the territory, and the frequency of duet calls (which is also used for advertisement during territorial defence, Archibald 1976) increased. In mid-August, the pair constructed a nest of *Typha* reeds in the marshland and the female laid two eggs, both of which were removed by villagers.

On September 8, 2000, during a routine visit to the area, another bird was seen in the territory and repeated attempts by the resident pair to chase the visitor (duet calls, tertial-elevation struts and co-ordinated guard calls) failed to elicit a response. In a surprising move, the visitor attacked the resident female (identified by smaller size and posture during duet calls). At first, the male assumed threat postures and carried out displacement preens, tertial-elevation struts, and a directed walk threat at the visitor. These attempts failed to displace the visitor, which instead renewed attacks on the resident female. The visitor was smaller than the resident male, but larger than the resident female. The resident female and the visitor sparred for almost five minutes, pecking each other and indulging in rapid, violent bouts of jump-rakes. The resident female was clearly losing the battle; the larger size of the visitor could have proved to be an advantage. At this point, the resident male, which was otherwise circling the fighting pair of cranes, walked in and pecked the resident female. The resident female began running away from the visitor, giving alarm-calls, and the male responded by calling synchronously, but did not come to the rescue. The visitor became very aggressive and mounted a fresh attack on the resident female by kicking, jump-raking, wing-thrashing, sitting on the back of the bird and pecking the neck and head hard and rapidly, finally chasing the bird into a pond and forcing it to swim to the opposite bank. The male was now chasing the resident female as well, and clearly supporting the visitor, though he synchronously answered the alarm and guard-calls of the resident female.

On emerging from the lake, the resident female was pursued once again by the visitor. This time, the female deliberately, but cautiously, approached human observers standing on the side of the marshland and stood as close as 5 m. This dissuaded the visitor from attacking further and she

resorted instead to a watchful preening session from beside the male bird. The resident female, while drying her wings, gave continuous calls, all of which were answered by the male. Several times, the resident female made a move towards the male, which caused the visitor to stop preening and walk towards her. Each time, the resident female would walk back towards the humans, causing the visitor to back off. After nearly an hour, the resident male and the visitor managed to chase the resident female away. The whole incident took place over a period of 55 minutes (1655-1750 hrs).

The male, with the visitor, commenced construction of a nest an hour later. The nest site was shifted the next morning due to human disturbance, and both birds worked vigorously at the construction. No eggs were laid and the nest was found abandoned a week later. The new pair was not observed duetting until the end of October, when they were also observed contact calling in synchrony for the first time, and were first observed dancing only in August 2001. Though the nesting season for Sarus Cranes in the study area is July-October (pers. obs.), the pair constructed a nest in April 2001, but no eggs were laid. The pair constructed a nest again in September 2001, but disturbance by people and cattle dissuaded them from laying eggs.

The reason for re-pairing by the male was not entirely apparent, though the larger size and more aggressive nature of the visitor female may have caused the male to choose over the previous, smaller one. The incident fits into the "forced divorce hypothesis" wherein a third dominant individual is responsible for break-up; previous reproductive success cannot predict the divorce and the break-up does not necessarily improve reproductive fitness of the divorced members (Choudhury 1995). This is also the only recorded instance of "courtship-role reversal" in Sarus Cranes with females being sexually competitive and displaying aggression to choose a male. Recent reviews have shown that this phenomenon arises when parental investment is greater by males (Gwynne 1991). This aspect of Sarus Crane biology has not been explored and promises to be an exciting subject for study. Young cranes are sometimes thought to build nest platforms immediately after establishing a breeding territory (Archibald 2000). The building of a nest in the above pair of cranes uncharacteristically in April 2000 may be part of the behaviour seen in newly paired young cranes.

Mate change observation 2

In another case, mate change could be deduced from a physical abnormality in the female bird – the mid-toe of the right leg of the female was missing. In 1999, the pair had successfully hatched two chicks, both of which were colour banded in December 1999 and observed to disperse from their natal territory in June 2000. The pair was observed to nest in August 2000, but children removed both eggs and the pair did not renest. In November 2000, observations of the birds after the harvesting of paddy in the territory showed that the female was different, as evidenced by the presence of all toes on the feet. The male was presumed to be the same, since the territory being defended by the pair was exactly the same as that determined using colour-banded chicks the previous breeding season. The new pair nested in August 2001, villagers removed the eggs from the nest, and the pair renested 18 days later. The one egg from renesting hatched, but the chick disappeared within a week due to unknown circumstances. The pair did not renest following the death of the chick. The change of the female occurred between August and November 2000. In this pair, as in the previous case, mate change resulted in a decrease in immediate productivity and the male retained the territory. The pair was observed calling in unison in November 2000 and dancing a month later. The pair bonding after re-pairing, thus, was faster in this pair.

On mate change in cranes

Mate loss and divorce have been documented in Sandhill Cranes *Grus canadensis*. New pairs have been established in birds following separation or death of a partner (Nesbitt and Wenner 1987), and divorce has been observed in as many as 67% of 24 colour-banded pairs observed for 3-11 years (Nesbitt 1989). Though successful reproduction was seen to enhance the maintenance of a new pair bond, unsuccessful breeding was not necessarily always the cause for divorce (Nesbitt 1989). Also, as observed in the Sarus Cranes, territory was retained by males of separating pairs eight out of nine times (Nesbitt 1989). In another study on Florida Sandhill Cranes *G.c. tabida*, Nesbitt and Tacha (1997) recorded breaking of 44% of pair bonds; 32.3% of these were due to divorce. In this study, incidence of divorce was found to be related to failure to reproduce (Nesbitt and Tacha 1997). Territory was retained by males 92.9% of times, and females 69.2% of the time. In Eurasian Cranes *G. grus*, a hand-reared bird was recorded to change mates three times in seven years (Johnsgard 1983). Mate changing is known in almost all crane species in captivity, and data from captive birds suggests that mate changing is most common in the early years and stabilizes after birds find compatible partners (Swengel *et al.* 1996). In Sandhill Cranes, re-pairing of females that retained their territories was usually with younger males, while males re-paired with females of the same age as themselves, or older (Nesbitt 1989).

Mate changes in the Sarus in Etawah, however, occurred after cranes had bonded and even bred successfully. In the two breeding seasons after mate changing, the change of partner was observed to result in a decrease in productivity

of the pair in both cases. It is possible that productivity may be enhanced in the long run. Large-scale colour-banding of paired adults using individually colour-coded plastic bands and/or recording of duet-calls, which are known to be 'signatures' for a given pair (Wessling 2000), should be used to investigate mate changes in Sarus Cranes. Information on these aspects of behaviour of Sarus Cranes is entirely absent. These observations over two and a half years, of a very large number of breeding, territorial pairs, clearly indicate that not all Sarus pairs bond for life as is made out to be for the species.

On pair bonding and territoriality

A few other aspects of pair bonding and territoriality were observed during the study period. The first involves injury to the male just prior to the breeding season. In three pairs, the male was injured due to collision with electric wires, rendering one leg useless, preventing mating for the season. In one of these pairs, the nesting area, a perennial pond, was usurped by an adjoining pair, which did not have any natural wetlands in their territory. The nesting area was regained by the original owners after the leg of the injured male healed the following year. In the other two pairs, the adjoining pairs had sufficient area to nest in and did not perhaps need to usurp the territory of the pairs with the injured male. All three pairs had successfully weaned young the previous season, and observations of unison calls and absence of egg laying by females of all three pairs indicated that the female did not desert the males, and did not mate with other males.

In another instance, the male was alone for two years (gender recognized by posture during calls given while defending territory). Both years, the adjoining pairs could not appropriate any part of the territory. In February 2002, a female joined the male. In one other pair, the male's wing was injured badly, but the pair could successfully defend their territory from other pairs. The pair, however, did not breed in the three breeding seasons during which they were observed.

The second aspect involves death of the male: in only one pair the male was killed by electrocution after flying into live electric wires. The female, with her two fledged young, was ousted from the territory, most of which was appropriated by two pairs with territories adjacent to the territory of the female.

These observations suggest that it may not be possible for a female to defend territory alone. However, females with injured males seem to be able to successfully defend territories, as also single males. This is consistent with observations on Sandhill Cranes (Nesbitt 1989). The pattern also fits in with a male-dominated resource defence system (Greenwood 1980) where the male has a higher investment in securing and maintaining the resource (in this case, territory), and the female's mate choice is imposed upon the mating system of the species. It is, however, not necessary that similar trends hold good in other areas with Sarus Cranes that have a low number of non-breeding individuals.

On aggression and cognition

Although pecking and jump-rakes have been observed to be part of the agonistic behavioural repertoire in every species of crane, the fights in Sarus Cranes usually do not escalate beyond jump-rakes (pers. obs.), and the risk of physical damage is minimised. The birds, instead, resort to lower levels of non-physical aggression that include a wide range of postures and calls (described in Ellis *et al.* 1998). Observations in Etawah show that Sarus Cranes are capable of terrific violence against conspecifics.

An interesting feature of the incident where divorce was observed was that of the resident female seeking protection from the attacking visitor by walking up very close to humans. That the bird did it repeatedly suggested an understanding on its part that the visitor would not risk close approach to humans. Though farmers often remove eggs from nests to dissuade pairs from breeding in their fields, they rarely persecute adult birds. The observation suggests higher cognitive abilities in Sarus Cranes than was previously known.

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REFERENCES

ALI, S. & S.D. RIPLEY (1989): A Handbook of Birds of India and Pakistan. Volume 2. Megapodes to Crab Plovers. Oxford University Press, Bombay.

ARCHIBALD, G.W. (1976): The unison call of cranes as a useful taxonomic tool. Unpublished Ph. D. dissertation. Cornell University, Ithaca, New York.

ARCHIBALD, G.W. (2000): Michigan's whooping cranes. *ICF Bugle 26(4)*: 3.

CHOUDHURY, S. (1995): Divorce in birds: a review of the hypotheses. *Anim. Behav. 50*: 413-429.

ELLIS, D.H., S.R. SWENGEL, G.W. ARCHIBALD & C.B. KEPLER (1998): A sociogram for cranes of the world. *Beh. Proc. 43*: 125-151.

GREENWOOD, P.J. (1980): Mating systems, philopatry and dispersal in birds and mammals. *Anim. Beh. 28*: 1140-1162.

GWYNNE, D.T. (1991): Sexual competition among females: what causes courtship-role reversal? *TREE 6*: 118-121.

JOHNSGARD, P.A. (1983): Cranes of the World. Croom Helm, London & Canberra.

MASATOMI, H. (1994): Structure and function of crane dance. Pp. 146-148. *In*: The Future of Cranes and Wetlands (Eds: Higuchi, H. & J. Minton). Proceedings of the International Crane Symposium (ed.), Wild Bird Society of Japan, Tokyo, Japan.

NESBITT, S.A. (1989): The significance of mate loss in Florida sandhill cranes. *Wilson Bull. 101*: 648-651.

NESBITT, S. & T.C. TACHA (1997): Monogamy and productivity in Sandhill cranes. *Proc. North Am. Crane Workshop 7*: 10-13.

NESBITT, S.A. & A.S. WENNER (1987): Pair formation and mate fidelity in sandhill cranes. Pp. 117-122. *In*: Lewis, J.C. (ed.) Proceedings of the 1985 Crane Workshop, Platte River Whooping Crane Maintenance Trust, Grand Island, NE, USA.

SWENGEL, S.R., G.W. ARCHIBALD, D.H. ELLIS & D.G. SMITH (1996): Behaviour management. Pp. 31-43. *In*: Cranes: their biology, husbandry and management (Eds: Ellis, D.H., G.F. Gee & C.M. Mirande). Hancock House, Blaine, Washington.

WESSLING, B. (2000): Crane voiceprints. *The ICF Bugle 26 (Aug)*: 1-2.

13. DISTRIBUTION OF MASKED FINFOOT *HELIOPAIS PERSONATA* IN THE SUNDARBANS RESERVED FOREST OF BANGLADESH

Introduction

The Sundarbans Reserved Forest (SRF) of Bangladesh, the home of the Bengal Tiger, is a unique habitat for wildlife, especially for avian biodiversity. It is the world's largest contiguous block of mangrove forest, with an area of *c.* 6,017 sq. km, managed by the Forest Department since 1884 (Cannonizado and Hossain 1998). Of the total area, 4,143 sq. km is landmass, while 1,874 sq. km is water bodies. The Sundarbans mangrove forest is situated in south-western Bangladesh, between 21° 39' 00"-22° 30' 15" N and 89° 2' 00"-89° 54' 07" E. There are 32 species of mammals, 8 species of amphibians, 14 species of turtles, 30 species of snakes, 35 species of other reptiles, 186 species of birds (Hossain and Acharya 1994), 196 species of fishes (Bernacsek 2000) and 334 species of plants (Prain 1903) recorded. The Masked Finfoot *Heliopais personata* (G.R. Gray 1849 (1848)) is the only species of the Order Gruiformes found in the Sub-Himalayan region, in northeast India and in the Sundarbans of Bangladesh. This bird is also distributed in Myanmar, Malaysia and Thailand (Khan 2000). Grimmett *et al.* (1998) reported that the Masked Finfoot is a rare resident or visitor in Bangladesh. The Masked Finfoot found in Bangladesh Sundarbans is a resident. Not much literature is available on the biology of the Masked Finfoot in this region. Khan (2000) reported that it is endangered in Bangladesh and globally vulnerable.

The Masked Finfoot is a duck-like bird sparsely distributed over a large forest area of the Bangladesh Sundarbans. It is locally known as *Hans Pakhi*. Khan (2000) reported the Bangla name *Goilo Hansh*. This bird is usually found in tidal channels of dense swampy mangrove forest, which are relatively undisturbed. It was seen most of the time in pairs, standing at the shores of the small rivers and channels. These channels and small rivers are locally known as *khals*. Sometimes the birds were found sitting on the trunk of baen trees (*Avicennia officinalis*) inclined over the *khals*. The head, neck and some part of the back is visible while swimming. The Masked Finfoot is very shy, solitary, and sometimes tries to hide in the grass if approached by people or boats. Khan (2000) reported its breeding from July-August and nests at a height of 1-3 m on horizontal branches of trees, built with twigs.

Distribution

A total of 24 Masked Finfoot were sighted in the SRF from 1999 to 2001. They were mostly seen in the freshwater zone that is in the eastern part of river Shipsa of the Sundarbans mangroves. The maximum sighting was recorded while cruising in the Tambulbunia *khal*. Eight individuals were sighted in four different locations. This *khal* appeared to be relatively undisturbed. The maximum western limit of sighting of the Masked Finfoot is the Sarbatkhali *khal* of Khulna Range of the Sundarbans West Forest Division, which is also located in the freshwater zone, east of the river Shipsa. This bird is normally seen in the Katka and Kachikhali *khal* of the Sundarbans East Sanctuary and near the western entry point of the Mara Bhola *khal*, which is located in the moderately saltwater zone. Besides these sites, the Masked Finfoot was seen in the Bara Morogmari *khal* and Jongra *khal* of the Sundarbans East Forest Division. None were ever sighted in the saltwater zone (Fig. 1), though the area was extensively searched and inquiries made. This bird was sighted over an area of 2000 sq. km. Each site was far from the others, so the

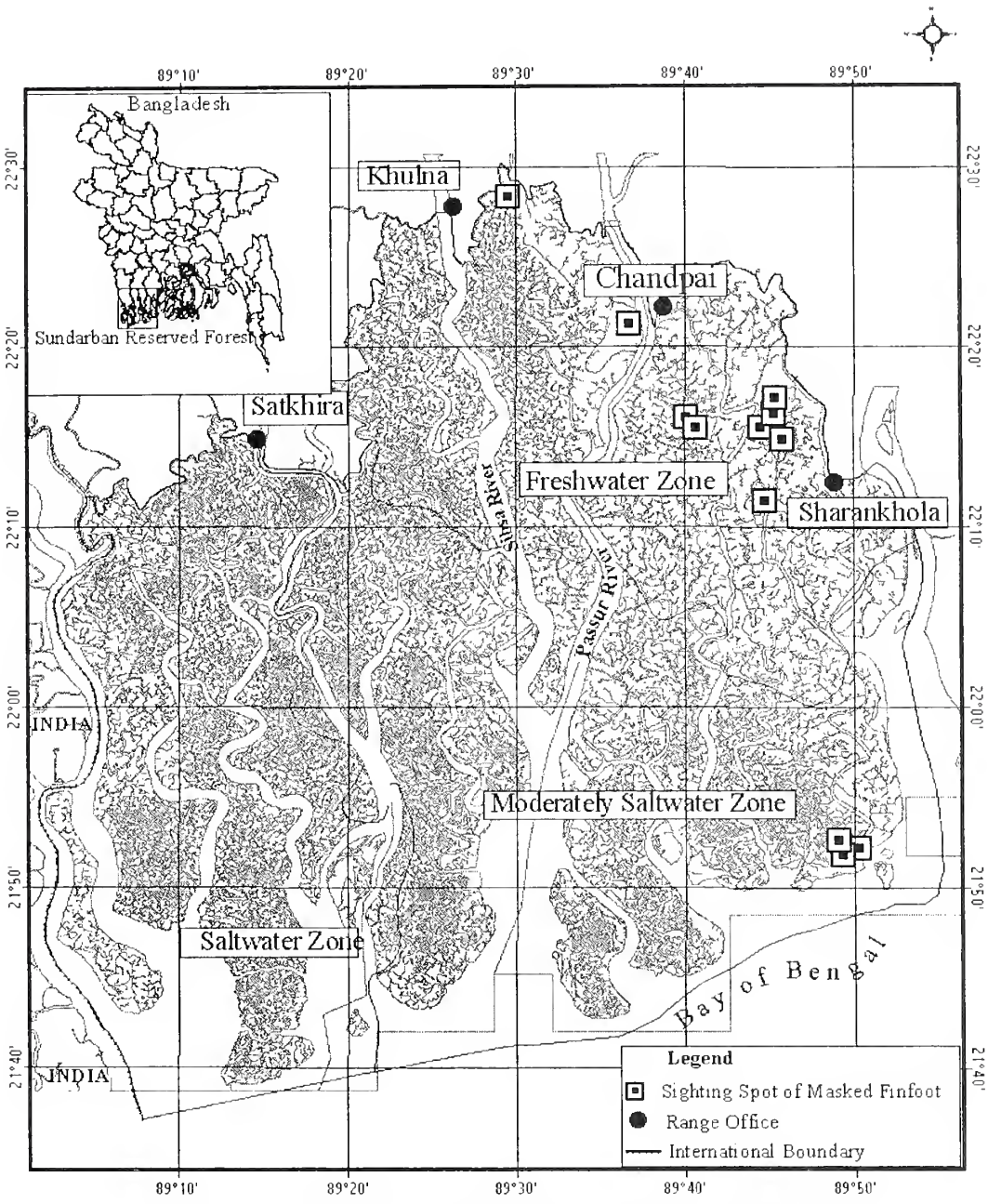

Fig 1: Map showing sighting spot of Masked Finfoot in Sundarban Reserved Forest

(Scale = 1: 500,000)

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chance of overlapping is almost nil. They were never sighted flying above the forest canopy (about 8-10 m) of Sundarbans, and their call was never heard during sightings. When trying to hide, they walk or swim away swiftly and fly low over short distances.

Information on breeding, nesting and poaching in Bangladesh Sundarbans should be collected. As the birds disappear from the area during harvesting of forest produce, there should be more undisturbed areas reserved for Masked Finfoot to increase their population. Certain forest areas of Sharonkhola and Chandpai Range of Sundarbans East Forest Division may be preserved thus.

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REFERENCES

BERNACSEK, GARRY (2000): Fisheries of the Sundarbans. *Interim Technical Report No. 1 Vol. 1. Main Report.* Sundarbans Biodiversity Conservation Project. Khulna. Bangladesh. Pp. 23-26.

CANNONIZADO, C.J. & MD. AKBAR HOSSAIN (1998): Integrated Forest Management Plan for the Sundarbans Reserved Forest. Vol. I. Mandala Agricultural Development Corporation and Forest Department, Ministry of Environment and Forest, Dhaka, Bangladesh. Pp. I-I.

GRIMMETT RICHARD, CAROL INSKIPP & TIM INSKIPP (1998): Birds of the Indian Subcontinent. Oxford University Press, India. Pp. 461-462.

HOSSAIN, Z. & G. ACHARYA (1994): Mangroves of Sundarbans – Volume II: Bangladesh. IUCN- The World Conservation Union. Pp. 257.

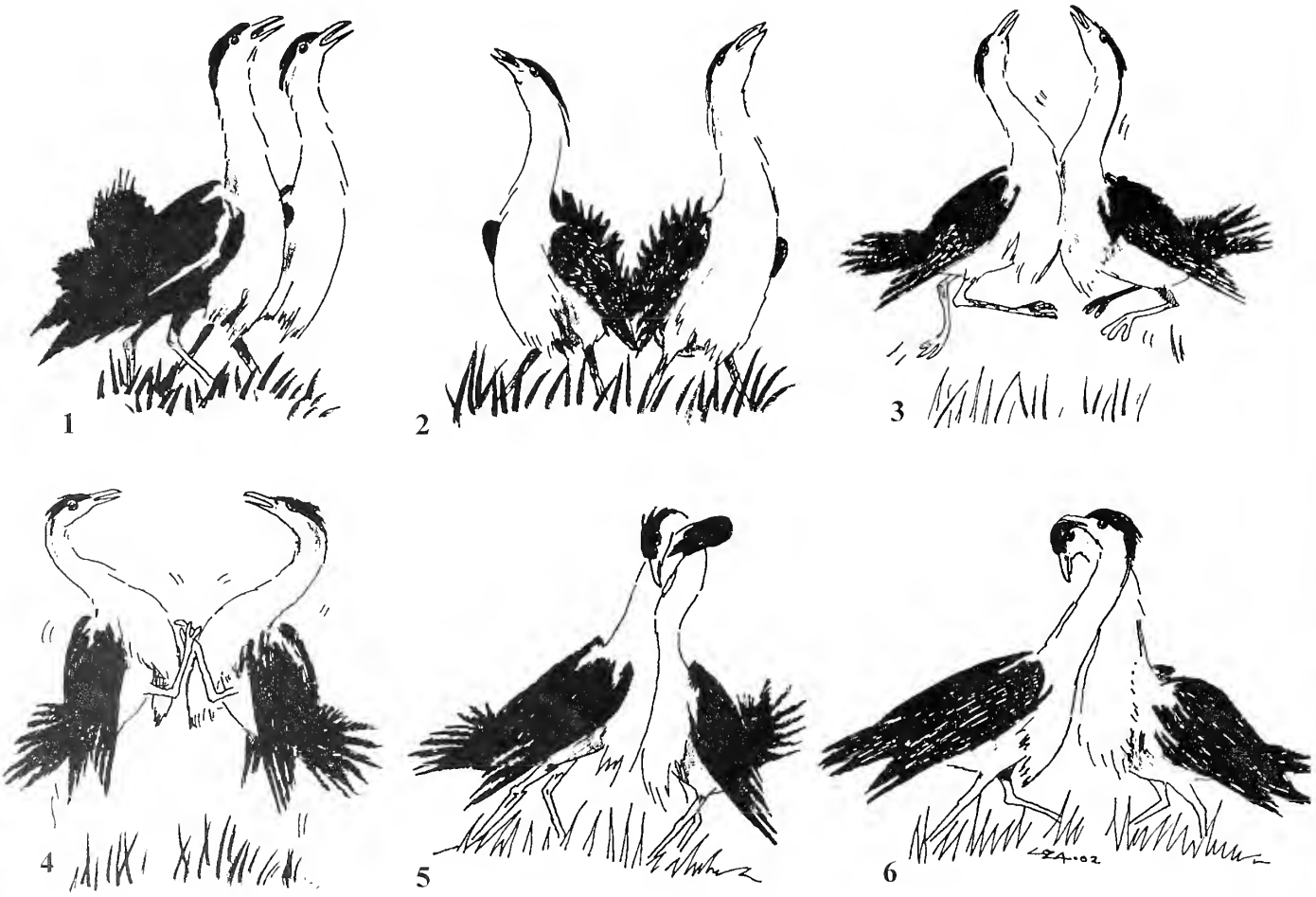
KHAN, ANISUZZAMAN M. (2000): Red Book of Threatened Birds of Bangladesh. IUCN-The World Conservation Union, Bangladesh. Dhaka. Pp. 39.

PRAIN, O. (1903): The Flora of Sundarbans. *Rec. Bot. Surv. India. 144*: 231-272.

14. TERRITORIAL FIGHTING BEHAVIOUR OF GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS*

Territorial fight in the Great Indian Bustard *Ardeotis nigriceps* occurs frequently among adult males during the breeding season (Rahmani 1989). Territorial fights between cocks were seen on seven occasions in Vingaber, Kachchh, Gujarat in the presence of females.

During territorial fights, males were in display and no change in posture between display and fighting was obvious on all the occasions except for the erecting of crown feathers. Rahmani (1989) also reported that the fighting posture is similar to the display posture. As soon as the intruder was seen, the owner approached it, either with a short flight (if the intruder was slightly away), or with a rapid walk. After this approach, both the males started marching parallel to each other with their tails half or fully cocked for about 5 to 25 m (Fig. 1), then



Figs 1-6. Sequence of territorial fighting behaviour of the Great Indian Bustard

stopped and start shaking the gular pouches laterally (3-5 times) (Fig. 2). Immediately after, both made a 360° rotation, walked to the place where they started, and repeated the same sequence for about 5 to 7 minutes. Later, both the birds faced each other, jumped at the same instant from the ground and dashed their breasts (Fig. 3), and legs against each other (Fig. 4), as reported by Rahmani (1989). Once they landed, both held each other by locking their necks (Fig. 5). This was followed by pecking (Fig. 6) by the owner of the territory or the winner. After nearly three minutes of sparring, the loser released himself from the winner and flew to his territory or another spot. The different postures (Figs 1-6) (Art by VG) show the sequence in territorial fighting behaviour.

Interestingly enough, probably the same males (not certain, since the birds were not colour- or radio-tagged) on three occasions shared the same place without territorial fighting when the females were not nearby. Both the cocks ignored each other and foraged very close for about 10 minutes, after which the intruder flew to his own territory. This could be a strategy to save energy in the absence of females, as it would be disadvantageous for the bird to expend energy fighting, which if stored would help while courting a female. All this could be part of the species' mating strategy.

Another rare observation made during the breeding season in 2000 was of nine males displaying at the same time within 500 to 1000 m from each other in Vingaber. This could be due to lack of proper display sites in other areas of the grasslands, or because more females congregate at this location (five females were sighted here compared to one and rarely two in other places). No territorial fight was observed at that time. In this case also, territorial fighting would be disadvantageous to the males involved, compared to those not involved, who would be able to spend more time and energy in display to attract females.

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REFERENCE

RAHMANI, A.R. (1989): The Great Indian Bustard. Final Report. Bombay Natural History Society. 234 pp.

15. SPOTTED DOVE *STREPTOPELIA CHINENSIS* FEEDING ON WINGED TERMITES

Spotted Dove *Streptopelia chinensis* (Gmelin) is well known to be a granivore. It feeds on grains of paddy, jowar and other cereals, lentils and pulses, grass and weed seeds (COMPACT HANDBOOK, Ali and Ripley, 1987). But there is no record of it feeding on insects. We note here our recent observation on Spotted Doves feeding on winged termites in Sarkarpathy, Pollachi division of the Indira Gandhi Wildlife Sanctuary and National Park, Tamil Nadu.

On June 27, 2002 at 0820 hrs, while monitoring a scrub jungle transect, the feeding behaviour of two Spotted Doves attracted our attention. To our surprise, the doves were found feeding on winged termites (dead and alive) on the roadside. A similar observation was made again at 0925 hrs, in the same habitat, but this time eight Spotted Doves were feeding together on the termites. As we were observing this behaviour, a Three-striped Palm Squirrel *Funambulus palmarum*, a Grey Junglefowl *Gallus sonneratii* and Sirkeer Malkoha *Phaenicophaeus leschenaultii* also arrived and started feeding on these termites very close to each other. While the others are known insectivores, doves feeding on winged termites is unusual and deserves mention, sighting of eight individuals feeding together on the termites clearly indicates that it is not an unusual feeding habit. Most likely, the Spotted Doves in this area are used to feeding on such seasonal insects or turn to insectivory during such seasons.

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16. MALABAR TROGON *HARPACTES FASCIATUS* PENNANT IN THE NILGIRIS UPPER PLATEAU, TAMIL NADU

On April 24, 2002 at the end of one of our bird community transects at Thiashola in the Nilgiris, Tamil Nadu, we heard an unknown, low, mewing call from inside the shola (Montane Wet Temperate forest). On following the call, we found a male Malabar Trogon *Harpactes fasciatus* perched in the middle canopy of a tall tree in the shola. Soon we heard another bird from about 40 m on the other side of the road. The call was a *cue-cue-cue* uttered frequently at regular intervals. Both the birds remained in the same patch for around ten minutes, while frequently flying from tree to tree. Later they flew away and could not be sighted again.

The Malabar Trogon has been reported as uncommon from the plains up to 1,500 m only (Ali and Ripley 1987) and hills up to 1,050 m (Ali 1999). This is the first record of this species from the Nilgiris Upper Plateau (one of the highest hill components of Western Ghats) at 2,150 m. Thiashola was revisited in May, June and July 2002, but no Malabar Trogon could be heard or seen. We presume that the species might be coming to the Upper Nilgiris only during the spring months, and return to the lower elevations before the onset of monsoon, when it becomes windy and cold.

In its range below 1,500 m it affects evergreen and moist deciduous forest, however, in the Nilgiris it was recorded in Montane Wet Temperate forests (shola). Thiashola forest is located in the southwest of the Nilgiris Upper Plateau, where the hill range abruptly falls to the low lying Coimbatore and Palakad division. Presumably, some of these birds might be coming higher up during summer, from the neighbouring Silent Valley forest, Neelambur Forest Division or Palghat section.

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REFERENCES

Ali, S. & S.D. Ripley (1987). Compact Handbook of Birds of India and Pakistan. 2nd Edn. Oxford University Press, Delhi. Pp. 275.

Ali, S. (1999). Birds of Kerala. 3rd Edn. Kerala Forest and Wildlife Department Thiruvananthapuram. Pp. 282.

17. FISH IN THE DIET OF THE BLACK DRONGO *DICRURUS MACROCERCUS* VIEILLOT

The Black Drongo *Dicrurus macrocercus* is well known as an omnivore, feeding predominantly on insects, occasionally on lizards, small birds and small bats. It has also been recorded feeding on flower-nectar, moths, butterflies and insects (COMPACT HANDBOOK, Ali and Ripley 1987). However, fish have not been reported in its diet.

On the morning of April 28, 2002, I was observing the feeding behaviour of White-breasted Kingfisher (*Halcyon smyrnensis*), Small Blue Kingfisher (*Alcedo atthis*), Black Kite (*Milvus migrans*), Brahminy Kite (*Haliastur indus*), House Crow (*Corvus splendens*) and Jungle Crow (*Corvus macrorhynchos*) in a small pond in Nalangkattalai village in Thiruvarur district, Tamil Nadu. The pond was almost dry because of the summer heat, owing to which most of the fish had been caught by the villagers. The rest had died and were floating on the muddy water.

I saw five Black Drongos arrive at the site, and immediately all of them started feeding on the floating dead fish with other birds. They frequently dived at the floating fish and with the prey in their beaks, perched on a nearby Neem (*Azadirachta indica*) tree to feed. The fish were about 10 cm long. These birds kept feeding and hovering over the pond from 0830 to 1200 hrs, as long as the prey was available. However, the major share of the fish prey went to the kites, which dived and captured the floating fish repeatedly with great agility.

Although the Black Drongo prefers open, fallow paddy fields and grazing land for feeding on a variety of insect fauna, the availability of easy prey, like floating fish, may have tempted them to use the resource, or scarcity of food may have forced them to go for the fish. This observation deserves notice since there is no published record of the species feeding on dead fish.

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18. GREAT-TUFTED MYNA *ACRIDOTHERES GRANDIS* — AN ADDITION TO THE BIRDS OF MEGHALAYA

The Great-tufted Myna *Acridotheres grandis* is also known as White-vented or Great Myna. It is distributed from northeast India to Sulawesi and Christmas Islands (Indian Ocean), while in India it was only known from Nagaland, Manipur and Mizoram (Ali and Ripley 1983), which was also the westernmost limit of its rangė. The first record in Assam was in 1986 when it was observed at Dimbruchara in Barail Reserve Forest in North Cachar Hills district (Choudhury 1991a). Thereafter, it appeared to be visible in almost all parts of Assam (Choudhury 1991b) suggesting a case of new and notable range extension.

On July 21, 2002 while travelling to Shillong from Guwahati in northeast India with Asad Rahmani and Kulojyoti Lahkar, I saw two Great-tufted Mynas at the 14th mile area (26° 05' N, 91° 53' E) between Jorabat and Byrnihat. The time was around 1530 hrs. The birds flew from Meghalaya to Assam; that stretch of the National Highway 40 has been marked as the interstate boundary. Although I recorded it in my notebook, I overlooked its significance as the species has become common even in Guwahati city since about one and half a decades. Subsequently, I cross-checked with records and realised that the species was never recorded in Meghalaya (Baker 1907; Choudhury 1991b, 2000; Godwin-Austen 1870a,b, 1872; Grimmett *et al.* 1998). The habitat was foothills in Meghalaya (Ri-Bhoi district), while it was a small, cultivated valley on Assam side (in Kamrup district) with human habitations and shops along the busy national highway.

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REFERENCES

Ali, S. & S.D. Ripley (1983): The Handbook of the Birds of India & Pakistan. Compact Edn. Oxford University Press, New Delhi (revised edn. 1987, Bombay).

Baker, E.C.S. (1907): The birds of the Khasia Hills, 2 parts. *J. Bombay Nat. Hist. Soc.* Vol. 17.

Choudhury, A.U. (1991a): New for Assam: the White-vented myna. *OBC Bulletin No. 13*: 20-23.

Choudhury, A.U. (1991b): Distribution of Orange-billed jungle myna in North-East India. *J. Bombay Nat. Hist. Soc. 88(2)*: 286-287.

Choudhury, A.U. (2000): The Birds of Assam. Gibbon Books & WWF-India, North-East Regional Office, Guwahati.

Godwin-Austen, H.H. (1870a): 1870. A list of birds obtained in the Khasi and North Cachar Hills. *J. Asiatic Soc. Bengal 39(2)*: 91-92.

Godwin-Austen, H.H. (1870b): Second list of birds obtained in the Khasi and at their base in the Mymensingh and Sylhet districts. *J. Asiatic Soc. Bengal 39(3)*: 264-275.

Godwin-Austen, H.H. (1872): Third list of birds obtained in the Khasi and Garo Hill ranges, with some corrections and additions to the former list. *J. Asiatic Soc. Bengal 41(2)*: 142-143.

Grimmett, R., C. Inskipp & T. Inskipp (1998): Birds of the Indian Subcontinent. Christopher Helm (Publishers) Ltd., London.

19. AN OBSERVATION OF MATE SELECTION IN THE HOUSE CROW *CORVUS SPLENDENS*: AN APPARENT INSTANCE OF MODIFIED LEKKING IN A CORVID

Introduction

Corvids are a wide ranging and diverse group of birds. Often considered the most intelligent of birds, their social systems are highly varied. Perhaps because of the general ease with which they can be observed the behaviour of the corvids has been studied extensively. Corvids have proven especially important in the study of intelligence (Welty 1979; Gill 1995) and breeding behaviour (Skutch 1976). Mate selection is one of the most critical components of any social structure and corvids are known to be fussy about the mates that they select. Many extensive studies of breeding behaviour in corvids have been conducted [Ratcliffe 1997 (ravens); Woolfenden and Fitzpatrick 1984 (Florida Scrub-Jay); Yeates 1934 (Rook); Marzluff and Balda 1992 (Pinyon Jay); Kilham 1989 (American Crow and Northern Raven)]. It has been generally observed that these birds form close pair bonds (Angell 1978; Goodwin 1986) and many species mate for life. Goodwin (1986) notes that "for all species whose behaviour is reasonably well known breeding adults live in pairs" and that ritual feeding of the female by the male is a common part of the mating ritual in many species. Here we report an observation of breeding behaviour in the House Crow (*Corvus splendens*) that represents some certain deviations from the known norm of corvid behaviour and is unusual for birds in general.

Although no monograph on them has been written, House Crows have been studied extensively, primarily because of the ease with which they can be observed. House

Crows have adapted to human habitation and have been closely associated with areas of human habitation for centuries (Gill 1995); and are rarely found away from human habitations (Ali and Ripley 1986). Their distribution around the Indian subcontinent, Africa, and the Middle East is closely tied to human settlements and shipping routes, by which they are believed to have dispersed (Feare and Mungroo 1989; Pilcher 1986; Bijlsma and Meininger 1984). Such close association with humans has provided many opportunities for the study of House Crow breeding behaviour. They are generally described as being monogamous and pairing for life (Madge and Burn 1994; Ali and Ripley 1986), although Bijlsma and Meininger (1984) describe observations of trios of birds which they believed to be pairs with an extra individual and Goodwin (1986) reports anecdotal evidence of occasional promiscuity. The most extensive study of House Crow breeding behaviour was conducted by Lamba (1963) who records House Crows forming large flocks at the beginning of the mating season in which pair bonding occurs, but does not describe how mates are selected. He goes on to note that the House Crow "does not like to make a public exhibition of its connubial affections" and, indeed, the only description of copulation behaviours we could find was Acharya (1951) who describes two instances of copulation between apparently pair bonded birds that he observed from his bicycle on a street corner in India. We have been unable to find any detailed description of how mate selection in House Crows occurs. We report here an observation of mate selection by a female House Crow in a situation resembling a modified lek.

In lekking behaviour, several males gather in a small area and defend arenas in which they display to attract mates. Females typically choose from amongst the displaying males and depart after copulation (Alcock 1998). Lekking is well known in artiodactyl mammals (Nefdt 1995; Gosling and Petrie 1990; Clutton-Brock *et al.* 1989), and in birds. Lekking in birds has been principally recorded in shorebirds (Pruett-Jones 1988; Höglund *et al.* 1993) and gallinaceous birds (Rintämaki *et al.* 1995; Wiley 1980), but has also been documented in certain passerines (Snow 1956). To our knowledge, no instances of lekking or lek-like behaviour has ever been recorded in corvids.

Males may benefit from such behaviour by increasing their chances of copulating with females by locating themselves in an area where females congregate, associating with other males of "higher quality" (those that score more copulations), by increasing the levels of female stimulation with multiple displays, or by easing the ability of females to compare males, thus creating a mating system preferred by the females. Such advantages are functional when females want to choose a male based on physical indications of genetic fitness, when any further contribution to the rearing of the young beyond fertilization is irrelevant. It is difficult to explain group displays of males in a species in which the parents remain paired and raise offspring together, ostensibly for multiple breeding seasons, except as a display system preferred by females.

Observation: The incident of lek-like behaviour was observed in late May on a suburban street in the G-6 district of Islamabad, Pakistan. This area is characterized by single family houses and some small businesses. Several parks exist in the area comprised of open woodland and meadows. Whilst driving near one such park, a group of House Crows (identified as *Corvus splendens splendens* as per Grimmett *et al.* 1999) were observed behaving in an interesting fashion. The car was parked across the street from the crows and used as a blind in order to observe their behaviour. There was no apparent reaction by the crows to this action.

Six crows were standing on the street corner in a broad semicircle around another individual. These first six birds were ardently engaged in what appeared to be courtship behaviour. They were bending forward from the pelvis, arching their necks, and drooping their wings while emitting a loud *kaaa* call. These actions appeared to be aimed at the seventh bird, rather than each other, as they frequently turned sideways in order to attract her attention. (It is not possible to distinguish the sexes visually, this sex determination is based on subsequent behaviour.) While this activity was going on, the seventh bird walked up and down the line, silently watching them. Periodically she would stop and pay special attention to one of the individuals, at which point he would face her and bob his head in addition to the previously described actions. The other birds would make a greater effort and swing from side to side at these times, apparently to attract the female's attention.

After engaging in the above behaviour for approximately 10 minutes the female stopped in front of the second bird from the right of the line and emitted a series of *kaaa* calls while bobbing her head. At this signal, the male mounted her and copulation occurred (the basis for the sex determinations). After copulation, these two birds flew off in the same direction and were lost to view. The remaining males (these birds are presumed to be males because they were engaged in the same display behaviour as the one known male) continued to display on the corner for several minutes until a human walking down the sidewalk interrupted their display. After he passed, the crows resumed their display on the street corner in an apparent attempt to attract additional females.

Discussion

The occurrence reported above is but a single observation, and so may be an aberration or the norm of

House Crow mating behaviour. Different descriptions of mating and breeding systems in the House Crow emphasize different characteristics and apparently reflect a flexible mating system. Although the House Crow is consistently described as forming strong pair bonds that persist over many breeding seasons and remain strong within flock structure, no description of their mate selection process has previously been available.

The behaviour described above does not appear to be a true lek, as none of the males involved appeared to defend any territory. In fact, while the female was present they were virtually shoulder to shoulder. The resemblance to a lek is uncanny in all other respects though. The female bird clearly inspected the performances of all the males, ultimately choosing only one to copulate with. This situation is also unusual in that the pair apparently bonded in this process and left the arena together. If indeed this is a mating system in which lekking results in the formation of a pair bond it is, to our knowledge, unique among lekking species. Such a situation would provide evidence that the female preference hypothesis (Alcock 1998) of lek evolution should be valid for at least some species.

As an alternative to lekking behaviour, it is possible that this episode reflects an instance of cooperation among males to attract females. A group of several males displaying together will certainly be more noticeable than a single male. It is possible that in spite of the increased competition from other adjacent males, there is an overall advantage in being part of such a group as more females will be attracted to it. This hypothesis seems unlikely, however, in consideration of the high density of House Crows in the area and the likelihood of encountering a member of the opposite sex without difficulty. Regardless of the exact reasoning behind it, it is our opinion that this observation is a novel instance of corvid behaviour and warrants further studies of the breeding behaviour of the House Crow.

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REFERENCES

ACHARYA, HARINARAYAN G. (1951): Mating of the House Crow (*Corvus splendens splendens* Viellot). *J. Bombay Nat. Hist. Soc. 50*: 170.

ALCOCK, JOHN (1998): Animal Behavior: An Evolutionary Approach. Sinauer Associates, Inc.; Sunderland, MA. pp. 510-517.

ALI, SÁLIM & S. DILLON RIPLEY (1986): Handbook of the Birds of India and Pakistan 2nd edn. Oxford University Press, New Delhi.

ANGELL, TONY (1978): Ravens Crows Magpies and Jays. University of Washington Press, Seattle.

BIJLSMA, ROB G. & PETER L. MEININGER (1984): Behavior of the House Crow, *Corvus splendens*, and additional notes on its distribution. *Le Gerfault 74*: 3-13.

CLUTTON-BROCK, T.H., M. HIRAIWA-HASEGAWA & A. ROBERTSON (1989): Mate choice on fallow deer leks. *Nature 340*: 463-465.

FEARE, C.J. & Y. MUNGROO (1989): Notes on the House Crow *Corvus splendens* in Mauritius. *Bull. Brit. Orn. Soc. 109*: 199-201.

GILL, FRANK B. (1995): Ornithology. 2nd edn., W.H. Freeman and Co., New York.

GOODWIN, DEREK (1986): Crows of the World. 2nd edn. British Museum (Natural History), London.

GOSLING, L.M. & M. PETRIE (1990): Lekking in Topi: A Consequence of satellite behavior of small males at lek sites. *Animal Beh. 40*: 272-287.

GRIMMETT, RICHARD, CAROL INSKIPP & TIM INSKIPP (1999): A Guide to the Birds of India, Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka and The Maldives. Princeton Univ. Press; Princeton. NJ; P1. 91, p. 597.

HÖGLUND, J., R. MONTGOMERIE & F. WIDEMO (1993): Costs and consequences of variation in the size of ruff leks. *Beh. Ecol. and Sociobiology 32*: 31-40.

KILHAM, LAWRENCE (1989): The American Crow and the Common Raven.

LAMBA, R.S. (1963): The nidification of some common Indian birds. *J. Bombay Nat. Hist. Soc. 60*: 121-133.

MADGE, STEVE & HILARY BURN (1994): Crows and Jays: A Guide to the Crows and Jays of the World. Houghton Mifflin Co., Boston, MA.

MARZLUFF, JOHN M. & RUSSELL P. BALDA (1992): The Pinyon Jay Behavioral Ecology of a Colonial and Cooperative Corvid. T & A D Poyser, London.

NEFDT, RORY J.C. (1995): Disruptions of matings, harassment and lek-breeding in Kafue Lechwe Antelope. *Animal Beh. 49*: 419-429.

PILCHER, C.W.T. (1986): A breeding record of the House Crow in Kuwait with comments on the species' status in the Arabian Gulf. *Sandgrouse 8*: 102-106.

PRUETT-JONES, S.G. (1988): Lekking vs. solitary display: Temporal variation in the Buff-breasted Sandpiper. *Animal Beh. 36*: 1740-1752.

RATCLIFFE, DEREK (1997): The Raven: A Natural History in Britain and Ireland. T & A D Poyser, London.

RINTAMAKI, P.T., R.V. ALTALO, J. HOGLUND & A. LUNDBERG (1995): Male territoriality and female choice on Black Grouse Leks. *Animal Beh. 49*: 759-767.

SKUTCH, ALEXANDER F. (1976): Parent Birds and Their Young. University of Texas Press. Austin.

SNOW, D.W. (1956): The dance of the Manakins. *Animal Kingdom 59*: 86-91.

WELTY, JOEL CARL (1979): The Life of Birds. Saunders College Publishing, Philadelphia.

WILEY, R. HAVEN JR. (1980): The Lek Mating System of the Sage Grouse. pp. 158-167. *In*: Birds. W.H. Freeman and Co., San Francisco.

WOOLFENDEN, GLEN E. & JOHN W. FITZPATRICK (1984): The Florida Scrub Jay Demography of a Cooperative-Breeding Bird. Princeton University Press, Princeton, N.J.

YEATES, G.K. (1934): The Life of the Rook. Philip Allan, London.

20. NESTING BEHAVIOUR AND UNUSUAL FEEDING PATTERN IN COMMON WOODSHRIKE (*TEPHRODORNIS PONDICERIANUS*)

On April 9, 2002 as part of a project 'Conservation of Rare and Endangered Biodiversity of Gujarat (CREB)', we were surveying forest area near Kojachora village (69° 27' N; 23° 15' E), Mandvi taluka, Kachchh, Gujarat. Around 1110 hrs, one of us (JP) spotted a nest of a Common Woodshrike (*Tephrodornis pondicerianus*) on *Acacia senegal*, about 3 m above the ground. The whole patch of forest was dominated by *A. senegal,* interspersed with *Euphorbia caducifolia.* The terrain was undulating and the ground was sparsely covered with grasses like *Aristida adscensionis* and *Dactyloctenium sindicum.* The average tree height was 3.5 m, shrub height 2.5 m and shrub cover was about 40 to 50 % with *Premna resinosa* and *Grewia tenax.*

The nest was constructed in the fork of a leafless secondary branch. It was a cup-like nest, built of soft bark and threads, braced with cobwebs, which also helped to camouflage it. However, it was not protected from the scorching heat. As we approached the nest to check for the presence of chicks, we heard sharp alarm calls from a single individual. From its swift rush towards the nest, we presumed it was a female. After a few minutes, we heard *chip-chip* calls from the nest and saw three small chicks, which were continuously being visited by the mother bird. They were blind, small and naked, demanding food with open mouths. We noticed that within 4-15 m area, the adult bird was fetching deep reddish-brown flowers of *E. caducifolia* and feeding it to the hatchlings. It also brought greenish-white and creamy white fruits of *Salvadora oleoides* and *Acacia senegal*, respectively. In selecting the food for the hatchlings, the adult bird showed maximum preference for *E. caducifolia*, followed by *A. senegal* and *S. oleoides*. Feeding visits slowed down with the increase in atmospheric temperature, which seems crucial in reducing the frequency of this activity.

According to Ali (1945, 1996) and Sunderaraman (1989), Common Woodshrike usually feeds on insects and spiders, but in this case it fed on flowers and fruits as an optional food. This shows that during scarcity of food, the insectivorous Common Woodshrike might depend on flowers or fruits for sustenance, an additional survival strategy to thrive in an arid environment.

We also observed that although both the individuals shared duties for building the nest, incubation of eggs and care of young ones (Ali 1945, 1996); feeding the chicks was exclusively done by a single bird, probably the female.

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REFERENCES

ALI, S. (1945): The Birds of Kutch. Oxford University Press, Bombay. Pp. 22.

ALI, S. (1996): The Book of Indian Birds. 12th Edn. Bombay Natural History Society, Bombay. Pp. 240.

SUNDERARAMAN, V. (1989): On parental care of Wood Shrike (*Tephrodornis pondicerianus*). *J. Bombay Nat. Hist. Soc. 86(1)*: 95.

21. ALBINO BULBUL AT KEIBUL LAMJAO NATIONAL PARK, MANIPUR, INDIA

Loktak Lake (24° 30' N and 93° 48' E) in the Moirang district, Manipur, in north-eastern India is the major water body in the central part of this State. The lake, along with the surrounding areas, islands and hills, constitutes the Keibul Lamjao National Park, the only natural habitat of the Manipur Brow-antlered Deer *Cervus eldi.* We surveyed most of the

hills adjoining Loktak Lake during November 2000 as part of the Manipur Bush Quail Survey, conducted by the World Pheasant Association, South Asia Office, on behalf of the Indian Bird Conservation Network, Bombay Natural History Society. Though our target species was the Manipur Bush Quail *Perdicula manipurensis*, we also noted other birds found in the survey area, as primary information on birds from these areas are scarce.

While watching birds, a shiny white bird among the foliage caught our attention. On a closer look, we identified it as an albino Red-vented Bulbul *Pycnonotus cafer*. It was moving along with a mixed-species feeding group comprised of Red-vented Bulbuls, Yellow-breasted Greenfinches and Spotted-winged Grosbeaks. The albino bulbul had white plumage, even the flight feathers were glistening white. This we noticed when the bird flew from one branch to another. The bird's head was somewhat pale brownish and it had a scarlet-red vent that was quite conspicuous against its white plumage.

The bird apparently was less agile, while the other members of the mixed species flock were moving restlessly from one branch to another, feeding on insects from within the flowers and *Pinus* cones. It kept to a single cone for the greater part of an hour as we watched and photographed its each move. While the other birds fed on the insects from eight different trees, the albino bulbul restricted itself to a single tree. It also turned out to be somewhat shy. Despite our presence the other birds, even other conspecific individuals, fed on nearby trees, but the albino never came close. It confined itself in thick foliage. This might be attributed to an adaptive behaviour of keeping itself less conspicuous among the dense foliage, probably giving itself a better chance of escaping from predators. The white colouration would otherwise get noticed quite easily in the open.

Albino Red-vented Bulbuls have been reported twice (Baker 1915; Joshua 1996) from the Indian subcontinent. Joshua (1996) reported the same plumage pattern for the albino Red-vented Bulbul, a pale brown head and red vent.

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REFERENCES

BAKER, E.C.S. (1915): An albino bulbul. *Rec. Indian Mus. 11*: 351-352.

JOSHUA, J. (1996): An albino Red-vented Bulbul *Pycnonotus cafer*. *J. Bombay Nat. Hist. Soc. 93(3)*: 586.

22. USE OF LICHENS IN BIRD NEST CONSTRUCTION: OBSERVATIONS FROM BOLAMPATTI RANGE, TAMIL NADU, WESTERN GHATS

Introduction

Birds use lichens for nest building (Ali 1996), camouflage and feeding on small lichenophagous invertebrates which are present below the lichens (Richardson and Young 1977). Though extensive reports on the preferences of birds towards specific lichen species were available from Australia, Europe and North America (Richardson and Young 1977; Tibell and Gibson 1986), such detailed accounts were not available from India. Ali (1996) reported the use of lichens in nest building by several bird species such as flycatchers (*Muscicapa latirostris*, *M. ruficauda, Culicicapa ceylonensis* and *Hypothymis azurea*); sunbirds, babblers, minivets (*Pericrocotus flammeus*, *P. ethologus*, *P. roseus* and *P. cinnamomeus*), and to a lesser extent Black Bulbul (*Hypsipetes madagascariensis*). Considering the intricate relationships between lichens and other organisms, it is felt that the knowledge on use of lichen species by other organisms in India is still superficial and meagre (Krishnamurthy *et al.* 1993; Krishnamurthy *et al.* 1999). This paper enumerates the lichen species observed on a bird's nest.

During our survey in the Bolampatti II range of forests, Coimbatore district, Tamil Nadu (11° 2"-10° 54" N, 76° 33"-76° 46" E; Altitude 450-1,500 m), within the Nilgiri Biosphere

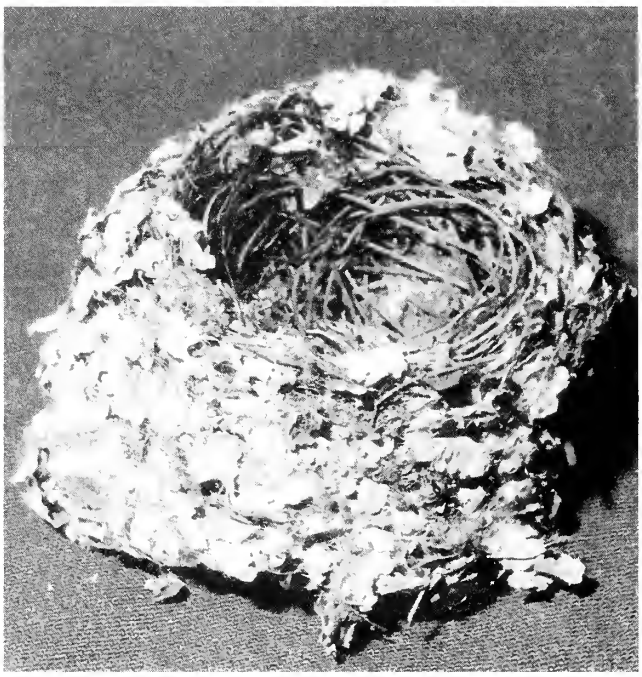

Fig. 1: Lichen covered Bird's nest from the Bolampatti II range of Forests, Western Ghats

Reserve we found a bird's nest (Fig. 1) completely covered with lichens, in the fork of the upper branches, 12 m from the ground, of an *Albizia odoratissima* (L.f.) Benth., within a Mixed Deciduous forest at 800 m above msl.

The cup-shaped nest was made of grass and fibres as described by Ali (1996). It measured 8 cm in diameter, 4.5 cm in height and the bulk of the inner nesting material was composed of a thin rachis of an imparipinnate compound leaf. The rachis was 8.5 cm long with a swollen base, properly bowered to form the nest.

Lichen species were found plastered compactly with cobwebs one above the other on the outer surface of the nest by the bird. These lichens *Bulbothrix tabacina* (Mont. Bosch) Hale, *Parmotrema mesotropum* (Mull. Arg.) Hale and *P. zollingeri* (Hepp.) Hale, were identified using standard literature (Awasthi 1989). No lichens were found within the inner cavity of the nest. *Parmotrema mesotropum* and *P. zollingeri* were used in large quantities to cover the lower lateral surfaces of the nest. The rim of the nest was lined with *Bulbothrix tabacina*. The growth form, lobe shape and size and colour of all the three lichen species were found to be similar.

Discussion: The presence of lichens on only the outer surface shows that the bird has used lichens to camouflage the nest from predators, and decorate. The golden plovers of St. Lawrence Island in the Bering Sea make their nests from the lichen *Thamnolia vermicularis* s.l. in a site with bright and conspicuous lichens around it, such that it perfectly camouflages the nest; in addition, the bird's colouring matches that of the lichen covered nest, so it is camouflaged when sitting on the nest (Sauer 1962). In this case also, the branch supporting the nest was completely covered by morphologically similar lichens such as *Hypotrachyna awasthi* Hale & Patw, *Parmotrema saccatilobum* (Zahlbr.) Hale and *Rimelia reticulatum* (Taylor) Hale & A. Fletcher.

The Bower Bird *Prionodura newtoniana* in Australia uses *Usnea* sp. and several other bird species use lichens to decorate their nests (Tibell and Gibson 1986; Seaward 1989). Bower Birds court and mate inside the nest and hence decorate it; a few Indian birds also do the same. The bird's selectiveness for specific lichen species has also been reported earlier. The Long-tailed Tit (*Aegithalos caudatus* L.) selectively collects *Evernia prunastri* (L.) Ach. for nest building (Richardson and Young 1977). In this case, the use of lichens could be to decorate and camouflage the nest from predators.

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REFERENCES

Ali, Sálim (1996): The Books of Indian Birds. 12th Edn. Bombay Natural History Society, 354 pp.

Awasthi, D.D. (1989): A key to the macro lichens of India and Nepal. *Journal of Hattori Botanical Laboratory 65*: 207-302.

Krishnamurthy, K.V., G.N. Hariharan & John T. Kocheril (1993): Mutualism between *Metisa* species (insect) and *Lepraria* species (lichen). *Phytophaga 5*: 97-99.

Krishnamurthy, K.V., John T. Kocheril & M. Mohanasundaram (1999): Lichen – Mite association. Pp. 29-55. *In*: Biology of lichens (Eds: Mukerji, K.G., B.P. Chamola, D.K. Upreti & Rajeev K. Upadhyay). Aravali Books International, New Delhi.

Richardson, D.H.S. & Colin M. Young (1977): Lichens and Vertebrates.

Pp. 121-144. *In*: Lichen Ecology (Ed.: Seaward, M.R.D.). Academic Press, London.

SAUER, E.G.F. (1962): Ethology and ecology of golden plover on St. Lawrence Island, Bering Sea. *Psychologische Forsch. 26*: 399-470.

SEAWARD, M.R.D. (1989): Contribution of lichens to ecosystems. Pp. 107-129. *In*: M. Galun. (ed.) CRC Handbook of Lichenology. Vol. II. CRC Press, Florida.

TIBELL L. & C.J. GIBSON (1986): Bower decoration with *Usnea* species in the Golden Bower Bird. *Lichenologist 18*: 95-96.

23. FIRST RECORD OF *POLYPEDATES LEUCOMYSTAX* (GRAVENHORST 1829) (ANURA: RHACOPHORIDAE) FROM SOUTHERN WEST BENGAL

The Common Indian Tree Frog *Polypedates maculatus* has been reported from all the districts of West Bengal (Mansukhani and Sarkar 1977; Sarkar 1984; Sarkar *et al.* 1992).

However, the Four-lined Tree Frog *Polypedates leucomystax*, which is so common in all the states of northeast India (Dutta 1997), has only been reported from the hilly Darjeeling and Jalpaiguri districts of northern West Bengal (Sarkar *et al.* 1992). It has also been reported from the plains of Bangladesh by Khan (1982).

On June 23, 2002 at 1930 hrs, we collected a male (SVL 58 mm) and a female (SVL 74 mm) *Polypedates leucomystax* from Rajpur (22° 20' N, 88° 35' E) in South 24 Parganas district of southern West Bengal, just 6 km south of Calcutta (= Kolkata). The female was hiding in the leaf axil of a banana plant (*Musa paradisiaca*), about 2 m above the ground, in a garden. The male was calling from a fence near a pool of water, 1.5 m above the ground. The specimens were deposited in the Zoological Survey of India, Calcutta (ZSI A 9603, male; ZSI A 9604, female). These specimens are the first record of the species from the plains of southern West Bengal, and extend the known range of the species by 500 km to the south.

We noted that the call of *P. maculatus*, which is sympatric, is a distinct *tak-tak-tak* while that of *P. leucomystax* is a sharp and loud *kraawk*. *P. leucomystax* was observed to be quite common in the area.

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REFERENCES

DUTTA, S.K. (1997): Amphibians of India and Sri Lanka — checklist and bibliography. Odyssey Publishers, Bhubaneshwar. Pp. 342.

KHAN, M.A.R. (1982): Wildlife of Bangladesh — a checklist. University of Dhaka, Dhaka. Pp. 174.

MANSUKHANI, M.R. & A.K. SARKAR (1977): Amphibians of Midnapore district, West Bengal. *Newsl. Zool. Surv. India 3(4)*: 156-157.

SARKAR, A.K. (1984): Taxonomic and ecological studies on the amphibians of Calcutta and its environs. *Rec. zool. Surv. India 81(3-4)*: 215-236.

SARKAR, A.K., M.L. BISWAS & S. RAY (1992): Amphibia — In Fauna of West Bengal. *Zool. Surv. India, State Fauna Series 3(2)*: 67-100.

24. A NOTE ON *BARILIUS BAKERI* (CYPRINIDAE: DANIONINAE) FROM KARNATAKA WITH REMARKS ON THE STATUS OF *OPSARIUS MALABARICUS* JERDON

Introduction

Day (1875-78) described 14 species of *Barilius*, grouping them on the basis of presence or absence of barbels. Jayaram (1999) listed 18 species of *Barilius*, including one subspecies, from the Indian region. Recently, three more species were described by Arunkumar and Singh (2000); Vishwanath *et al.* (2002) and Selim and Vishwanath (2002) from Manipur, bringing the current total to 21.

From Karnataka, Chandrasekhariah *et al.* (2000) list 6 species, with their distribution in the different east and west flowing drainages. Among the east flowing rivers, namely Godavari, Krishna and Cauvery, they list one species from Godavari – *B. bendelisis*, three species from Krishna – *B. barila*, *B. barna* and *B. bendelisis* and one species from Cauvery – *B. gatensis*. From the west flowing rivers, they report 3 species – *B. bakeri*, *B. bendelisis* and *B. canarensis*. Earlier Jayaram *et al.* (1982), reporting on the fishes of Cauvery, collected and recorded another species of *Barilius* from Karnataka, *B. vagra vagra*. There has been no report of *B. vagra vagra* subsequently from Cauvery, and furthermore,

Jayaram (1999) recently restricted the distribution of *B. vagra* to North India, Bangladesh, Pakistan and Sri Lanka. Also, the species *B. barila* and *B. barna* reported by Chandrasekhariah *et al.* (2000) are so far known only from North Indian rivers up to Orissa, and in Bangladesh and Nepal. Summing up the above details, there seem to be authenticated reports of only 4 species in Karnataka, namely *B. bakeri, B. bendelisis, B. canarensis* and *B. gatensis*.

Barilius bakeri has been recorded from the high ranges of Kerala and from the west flowing rivers of South Canara. Recently, a specimen of *B. bakeri* was collected from the east flowing drainage of the Krishna system in Chikmagalur district. A report on the specimen collected and a comparison of the species with the closely related *B. canarensis* is discussed. Remarks are made on the barbels in these fishes, a character used in identification keys of the *Barilius* species.

Material

1 ex., 80 mm SL, Honagodu, Chikmagalur, 700 m, 18.vi.2002, Regn. No. F. 7005.

Description

D. 3/10; P. 1/13; V. 1/8; A. 3/13; C. 19; L1. 39; Predorsal scales 16; L. tr. 9/3½.

Body depth 3.1 and head length 3.6 in standard length (SL). Predorsal distance 1.9, prepelvic 1.9, preanal 1.51 in SL. Pectoral fin length 4.5, pelvic fin length 6.7, height of dorsal 6.2, and height of anal 5.8 in SL. The base of dorsal fin 5.34 and that of anal fin 4.9 in SL. Snout 3.23 and eye 3.3 in head length. Eye diameter 1.02 in snout and 1.16 in interorbital width. Height of caudal peduncle 2.64 times in its length. Two pairs of minute barbels present; maxilla extends to anterior third of eye. A row of ten small spots present on mid-lateral side with an additional row of 2-3 spots in the anterior half of the body.

Discussion

Day (1875-78) remarks that *B. bakeri* is very closely related to *B. canarensis*, of which it may be a local variety. He mentions that *B. bakeri* forms the type of the genus *Pterosparion* Gunther, excluded from *Barilius* on account of its possessing more than 9 branched rays and suborbitals entirely covering the cheeks. But Day considered the subdivision of the genus undesirable since *Barilius gatensis,* with an equally broad suborbital ring, has 8 branched dorsal rays. Of all the *Barilius* species reported so far from India, only two species, namely *B. bakeri* and *B. canarensis,* have more than 10 branched dorsal rays (10-11 vs. 7-9). Except for *B. gatensis*, which has 8-9 branched rays, all other species have only 7-8 branched rays.

Though both *B. bakeri* and *B. canarensis* have several overlapping biometric characters, they can be readily distinguished on the basis of the size, number and position of spots. As is evident from Day's plate, the lateral spots are actually large blotches numbering 8 and extending to the upper half of the body in *B. canarensis* (pl. CXLIX, fig. 1), whereas in *B. bakeri* (pl. CLI, fig. 2) these are small and regular, numbering 10 and are arranged along the mid-lateral side of the body. In addition, Day mentions the presence of only one row of spots in *B. bakeri* and distinguishes the same from *B. canarensis* with one or two rows of spots. In the specimen of *B. bakeri* collected from Karnataka, there is an additional row of 4-5 spots in the anterior half of the body; this character is also seen in other *B. bakeri* specimens from Kerala, in the collections of this Station.

Under the description of *B. canarensis*, Day remarks on *Opsarius malabaricus* Jerdon while synonymising the same with *B. canarensis*. Based on his observation on a series of specimens of *O. malabaricus* collected from Canara, he remarks that there is no difference except in the height of dorsal fin and a row of small blue spots (9-12) along the middle of the sides, sometimes two rows being present in the first third of the body. From the above description of Day and our observations on *B. bakeri* specimens, it can be concluded that *O. malabaricus* should be a synonym of *B. bakeri* rather than *B. canarensis*. Also the distribution of *B. canarensis* (as also given by Menon 1999) will be only Canara (Karnataka) and not Kerala. *B. bakeri* has a wider distribution and is found in most of the west flowing rivers of Kerala. Biju *et al.* (2000) describe its occurrence in 19 out of the 39 west flowing rivers of Kerala surveyed by them.

Regarding the number of barbels in these species, Day and subsequent workers describe them as lacking the same. However, from the specimens examined by us two pair of very minute barbels are seen in both the species.

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REFERENCES

ARUNKUMAR, L. & H.T. SINGH (2000): Bariline fishes of Manipur, India, with the description of a new species: *Barilius lairokensis*. *J. Bombay Nat. Hist. Soc. 97(2)*: 247-252.

BIJU, C.R., K.R. THOMAS & C.R. AJITH KUMAR (2000): Ecology of hill streams of Western Ghats with special reference to fish community. Final Report. Bombay Natural History Society, Mumbai. 203 pp

CHANDRASEKHARIAH, H.N., M.F. RAHMAN & S. LAKSHMI RAGHAVAN (2000): Status of fish fauna in Karnataka. Pp. 98-135. *In*: Endemic Fish Diversity of Western Ghats (Eds. Ponniah, A.G & A. Gopalakrishnan). NBFGR-NATP Publication-1, National Bureau of Fish Resources, Lucknow, U.P., India. 347 pp.

DAY, F. (1875-1878): The Fishes of India; being a Natural History of the fishes known to inhabit the seas and the freshwaters of India, Burma, Ceylon. Text and Atlas in 4 parts. London: xx + 778 pp; 195 plates.

JAYARAM, K.C. (1999): The freshwater fishes of the Indian Region. Narendra Publishing House, Delhi (India): 1-551, pls I-XVIII.

JAYARAM, K.C., T. VENKATESWARULU & M.B. RAGHUNATHAN (1982): A survey of Cauvery river system with a major account of its Fish Fauna. *Rec. zool. Surv. India, Occ. Paper No. 36*: 1-115.

MENON, A.G.K. (1999): Checklist, Freshwater fishes of India. *Rec. zool. Surv. India, Occ. Paper No. 115*: 1-366.

SELIM, K. & W. VISHWANATH (2002): A new cyprinid fish species of *Barilius* Hamilton from the Chatrickong river, Manipur, India. *J. Bombay Nat. Hist. Soc. 99(2)*: 267-270.

VISHWANATH, W. & W. MANOJ KUMAR (2002): A new cyprinid fish of the genus *Barilius* Hamilton, from Manipur, India. *J. Bombay Nat. Hist. Soc. 99(1)*: 86-89.

25. OBSERVATIONS ON TWO CATFISH SPECIES FROM BANGALORE DISTRICT, KARNATAKA

While working on fish collections from Bangalore district, six catfish species were encountered of which two species *Sperata aor* (Hamilton) and *Mystus cavasius* (Hamilton) need special mention, since they do not conform to the keys provided, nor agree with the figures given in the standard books, namely Talwar and Jhingran (1991) and Jayaram (1999), used by fish workers.

***Sperata aor* (Hamilton)**

Earlier known as *Pimelodus aor*, the species was placed under various genera, namely *Bagrus*, *Macrones*, *Mystus* (*Osteobagrus*), *Aorichthys*, *Mystus* (*Aorichthys*) and recently under *Sperata* (Ferraris and Runge 1999). Hamilton (1822) described the species with eight barbels, of which two reach the tail fin. He also provided a lucid figure of the same.

This long maxillary barbel and larger gape of mouth chiefly distinguish the species from its Indian congener *S. seenghala* Sykes. Both, Talwar and Jhingran (1991) and Jayaram (1999) provide Sykes' figure (after Day) of *seenghala* with a spatulate snout, smaller gape of mouth and smaller adipose dorsal fin. However, Talwar and Jhingran (1991) have given importance to the length of the barbel while distinguishing the species, which is reflected in the keys as well as in the text figures. Jayaram (1999) has overlooked this character; the *seenghala* (after Day) with smaller maxillary barbels has been figured to illustrate *aor*, and this character has also been deleted from the key. This can lead to misidentification of the species.

Recently, in a revision of the South Asian catfish genus *Sperata*, under which *aor* and *seenghala* (known from Indian waters) are included, Ferraris and Runge (1999), in their key to the four species distributed from Pakistan to Myanmar, further distinguish the species by the length of interneural shield, number of pectoral fin rays and gill rakers. *S. aor* is characterised by an interneural shield as long as the supraoccipital spine, pectoral fin rays 10 or 11, and gill rakers typically 19-20, while in *seenghala* the interneural shield is longer than the supraoccipital spine, pectoral fin rays 8-9, and gill rakers 13-15. In this species, they remark, the maxillary barbels typically extend no further than to middle of body, at least in larger individuals. Their figures 7 and 8 of synonyms depict specimens with smaller barbels, whereas figure 6 of the presumed holotype (illustration from Sykes) shows a specimen with a long maxillary barbel extending beyond the pelvic fin tip.

The three specimens in the present collection (159-165 mm SL) have longer maxillary barbels extending to middle of caudal, a rounded snout and a long adipose dorsal, and are in full agreement with Hamilton's figure of the species. The gill rakers number 21 and fin rays in pectoral are 10 (nine in the left pectoral fin of one specimen).

***Mystus cavasius* (Hamilton)** (Fig. 1)

Mystus cavasius is characterised by a long adipose dorsal starting immediately behind the rayed dorsal and a long maxillary barbel extending to the tail fin. In the keys provided for the species in standard fish books mentioned earlier, the nature of the caudal peduncle is taken into consideration to distinguish *horai* from a species complex, i.e. caudal peduncle narrow/ constricted vs. caudal peduncle fairly high/ not constricted. *M. horai* Jayaram is keyed to species with the former character with the least height of caudal peduncle being 3 times in its length (vs. its least depth about twice in its length being the common feature of a group of 3-5 species). In most books their proportion is given as 1.4

Fig. 1: *Mystus cavasius* (Hamilton)

for *M. cavasius*, which is also reflected in Day's figure of this species. However, in the figure by Hamilton it works out to be 1.9 times. In the two specimens collected from Bangalore (both 120 mm SL) this proportion is quite different, being 2.25 and 2.34; and further, there is also a constriction of the body at the end of the adipose fin (Fig. 1). Though a slender caudal peduncle, 3 times in its length is characteristic of *horai*, this is found to be 1.8 times in the figure provided in the original description. It is also seen in this figure that apart from a notch-like constriction behind the adipose dorsal and vertically below along the ventral profile, the caudal peduncle rather appears to flare out gradually behind this point of constriction.

Another difference observed in the present specimens is its very slender shape. The body depth is 4.46 and 4.72 in SL (vs. 4.3) and 6.15 and 6.29 in TL (vs. 5.5-6). Slight difference is observed in head length, being proportionately larger and length of fins relatively shorter. In other characters, the specimens agree with the description of *cavasius*. This species is said to attain a length of 18" (Day 1875-1878), whereas Hamilton remarks that it grows to 6" in the Ganges. Until larger specimens and more collections are studied, the present observation serves to extend the range of the proportion of the depth of caudal peduncle in its length to be 1.4 to 2.34 (earlier 1.4).

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We are thankful to the Director, Zoological Survey of India, Kolkata and Officer-in-Charge, Southern Regional Station for providing necessary facilities. Our sincere thanks are due to Dr. K.C. Jayaram for the literature on *Sperata*.

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REFERENCES

DAY, F. (1875-78): The Fishes of India being a natural history of the fishes known to inhabit the seas and freshwaters of India, Burma and Ceylon. Bernard Quaritch, London. xx + 778, 195 pls.

FERRARIS, C. JR. & K.E. RUNGE (1999): Revision of the South Asian Bagrid Catfish Genus *Sperata*, with the description of a new species from Myanmar. *Proc. Calif. Acad. Sci. 51(1)*: 397-424, 8, Figs. 7 tables.

HAMILTON, F. (1822): An account of the fishes found in the river Ganges and its branches I-VII. Archibald, Edinburgh Hurst, Robinson & Co, London. 1-405, pls. 1-39.

JAYARAM, K.C. (1999): The Freshwater Fishes of the Indian Region. Narendra Publishing House, New Delhi. 551 pp., Plates xviii.

TALWAR, P.K. & A.G. JHINGRAN (1991): Inland fishes of India and adjacent countries. Oxford and IBH Publishing Co., Pvt. Ltd., New Delhi, xx + 1158 pp.

26. REDESCRIPTION OF *SPALGIS EPIUS* (WESTWOOD) (LEPIDOPTERA: LYCAENIDAE) WITH EMPHASIS ON MALE GENITALIA

Introduction

Spalgis epius, a very small blue Lycaenid butterfly commonly called Ape Fly (Aitken 1894) is found in tropical India. During a survey in different localities of Jorhat, Assam in northeast India, to evaluate pests infesting bamboos, *Spalgis epius* was reared on a colony of *Chaetococcus bambusae* (Homoptera: Pseudococcidae), a globular coccid. Several adults of both sexes were examined for morphological details. Past studies were incomplete and do not provide a proper identification guide (Evans 1932). Moreover, previous works do not emphasise the structural details of adult genitalia (Bingham 1905). Illustrations were also insufficient and therefore a redescription of *Spalgis epius* is given.

Spalgis epius (Westwood)

1852. *Lucia epius* Westwood, Green. Diurn. Lep., Vol. II, 502.

1852. *Geridus epeus* Doubleday & Hewitson, Gen. diurn. Lep. (2): 502.

1879. *Spalgis epius* Moore, Proc. Zool. Soc. Lond., p. 137.

1880. *Spalgis epius* Moore, Lep. Cey., Vol. I, p. 71.

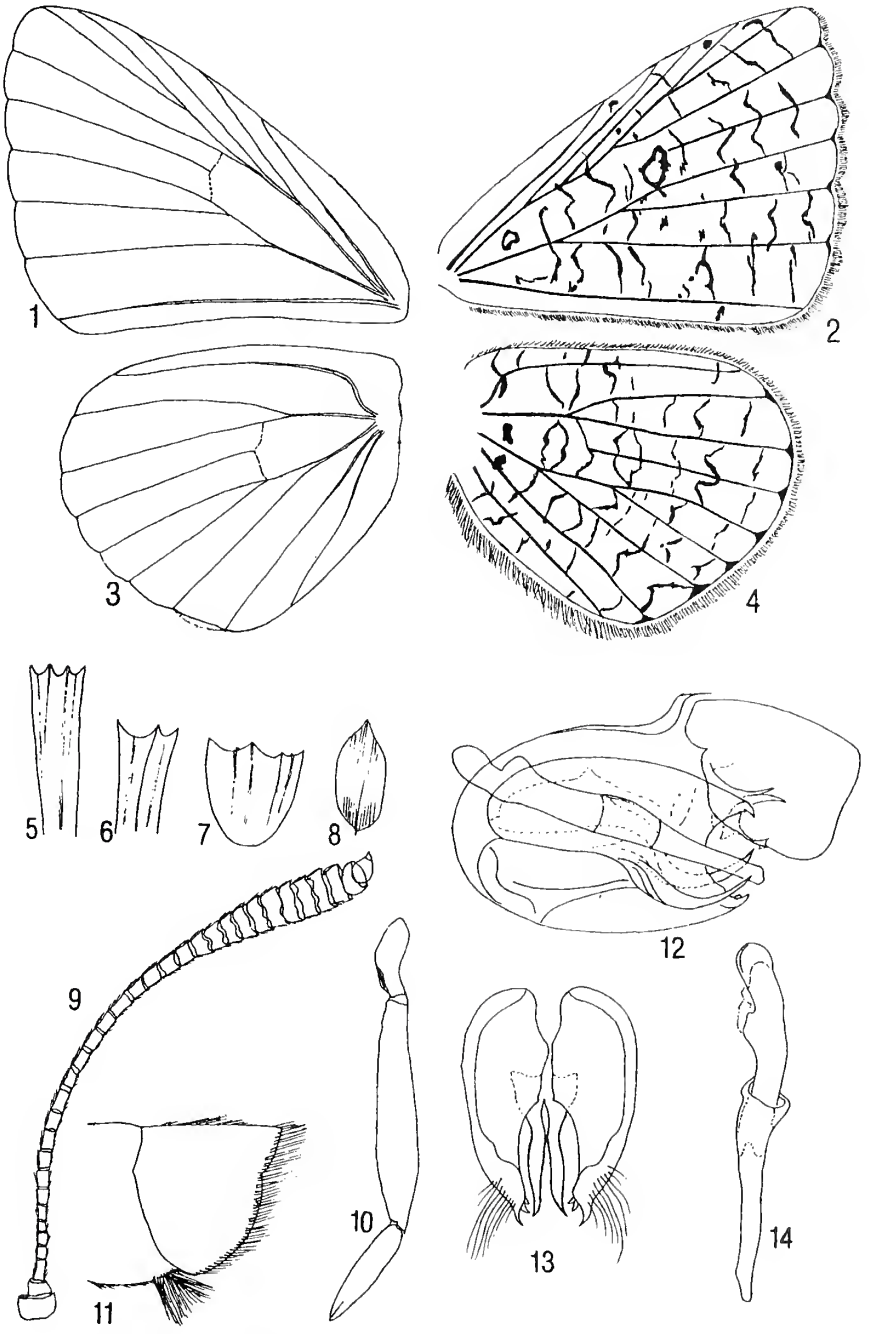
1890. *Spalgis epius* Niceville, The Butterfly of India, Vol. III, p. 55.

General: The Ape Fly is a small, slender, tailless Lycaenid butterfly with a dark brown upper side having a bluish tinge, and dull brown underside with wavy lines. There

is a prominent white spot on the forewing. Wing and colour of the butterfly are slightly different in male and female. Swift and erratic in flight, it settles with wings closed. It is generally found among herbs, shrubs, and among leaves and branches of small trees. Its wing span is 20 mm to 24 mm.

Distribution: This is an undistinguished and uncommon but not rare butterfly. Widely distributed in the plains, as well as known from the hills below 1219 m. Reported from Kolkata (earlier Calcutta), Malda in West Bengal, Gangum (Orissa), Bangalore, Karanja, Nilgiri hills, Bombay, Travancore, Assam, Burma & Ceylon (Moore 1880; Niceville 1928).

Seasonal occurrence: At higher elevation, found during summer and rarely in October. In the plains it is found throughout the year. However, it is deemed active during winter (Wynter Blyth 1955).



Figs. 1-15: 1. Female forewing: scales removed; 2. Female forewing with scales and patterns; 3. Female hindwing: scales removed; 4. Female hind wing with scales and patterns; 5, 6, 7, 8 Various scales present on wing; 9. Antenna of female; 10. Palpi, 11. Abdominal tip of female; 12. Male genitalia lateral view; 13. Male genitalia dorsal view-aedeagus removed; 14. male aedeagus

Head: Eyes yellow, palpi long, slender, upturned, second joint projecting half of its length (Fig. 10). Antennae clavate, reddish-brown, apically rest of flagellum marked with silvery white with black and brown basal articulations (Fig. 9). Antenna with 32 annules, 20 mm in length. Proboscis coiled, prehensile and slender.

Frenulum absent. Thorax black, covered with short golden brown and grey hairs. Apical and hinder ends pubescent, having long greyish black hairs. Legs short, banded with brown, femora delicately pilose beneath, fore tarsi of male having minute spines at sides.

Wing: Forewing triangular, apex slightly acute in male, little rounded (Fig. 2). Upper surface of both wings violet brown. Male forewing bears a quadrate spot near end of cell. In female, white patch is broader and in discal area, with a dark brown or black lunule. Cilia white. Wings having four types of scales. (Figs 5, 6, 7, 8).

Under surface greyish white, with several irregular and broken brown lines. In males with an indistinct brown oval patch. Eyespot absent in both sexes. In females, white marking more pronounced. Hind wings do not possess any tail (Fig. 3).

Wing venation: Fore wing (Fig. 1) costal vein short, nearly reaches middle half of costal margin. Third radial bifid giving rise to R3 and R4+5. M1 emitted from upper end of discal cell. M2 starts from end of cell angle and not directly connected to stalk of radial vein. Median vein M3 starts from lower angle of cell and proximity of M3 to cubitals gives an impression of 3 branches of cubitals. Anal vein lies along inner margin of forewing.

Costa of hind wing (Fig. 3) not thickened. Humeral vein absent. Second costal nervure splits to only radial (R) and 1st Median vein. M2 originates from end of cell angle. M3 emitted from lower angle of cell. 1st cubital Cu1 bifurcates from M3 near lower angle of cell, Cu2 emitted just before it. Anal vein splits near base to form A1 and A2.

Genitalia: Male genitalia complex, formed by modified 8th, 9th and 10th abdominal segments (Figs 12, 13). 8th segment protractile. 9th segment as a sclerotic ring, formed of tegumen dorsally and vinculum ventrally. Tergum form a shelf over the 10th segment; vinculum arch-like, having a small rectangular plate termed saccus. 10th segment or uncus broad, square, having a pair of curved claws, termed gnathos. Uncus bears no socii.

Pair of claspers or Herpes with large, curved, upturned and pointed claw. Herpes originates from a medial triangular plate that also provides articulation for penile musculature along theca.

Aedeagus, intromittant or phallic organ elongated, tubular, gradually narrowed down at blunt apex (Fig. 14) enclosed in a pouch-like endophallic tube that extends out from posterior part of genital complex. Tube having little sclerotization along its margin. Other end of tube enclosed by a floppy sheath, called theca with a rim called anellus. Tip of aedeagus lacks sclerotization. Herpes covers aedeagus from sides, and two plates, upper and lower valvula, cover whole structure. Upper tip of valvula projected like a short, pointed spine. Inner margin with spiny projections. Valvulae highly setose at tip.

Female genitalia slightly chitinized, rather simpler, having an evaginated outgrowth at tip of abdomen (Fig. 11).

Material examined: 5 females and 7 males collected from developing carnivorous larvae on colony of *Chaetococcus bambusae* infesting *Bambusa tulda* and *Bambusa balcooa* in Jorhat. 2 females and 2 males are kept in collection of Forest Protection Division, Rain Forest Research Institute, Jorhat, Assam (Collection No. B123). Adult female compared with a single female *Spalgis epius* in the collection of Forest Entomology Department, Forest Research Institute, Dehra Dun, Uttaranchal.

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REFERENCES

Aitken, E.H. (1894): The larva and pupa of *Spalgis epius* Westwood. *J. Bombay Nat. Hist. Soc. 8*: 485-487.

Bingham, C.T. (1905): Fauna of British India: Vol. 2 Butterflies. 1-528, Taylor & Francis, London.

Evans, W.H. (1932): Identification of Indian Butterflies. Bombay Natural History Society, Bombay. Pp. 454,

Niceville, L.D. (1928): The Butterflies of India, Burma and Ceylon. Vol. III, 1-503.

Moore, F. (1880): The Lepidoptera of Ceylon. L. Reeve & Co., London.

Wynter Blyth, M.A. (1955): Butterflies of the Indian region. Bombay Natural History Society, Bombay. 253 pp.

27. ADDITIONS TO THE LIGHT ATTRACTED BUTTERFLIES

Insects in general are known to be attracted to light. Of course, moths outnumber many other groups in this habit, and catches of moths at light sources have regularly been reported. However, little is known about the attraction of butterflies to light, as they are mostly diurnal, or such incidents go unnoticed.

In the past, Usman (1956) recorded a Lycaenid *Talicada nyseus* attracted to light at Bangalore. Donahue (1962) recorded butterflies attracted to light in India. Shull and Nadkerny (1967) have reported 18 species (Nymphalids, Pierids and Satyrids 5 each, Lycaenid 1, and Hesperiids 2) attracted to light in Surat Dangs. Recently, Sharma and Chaturvedi (1999) reported one more species of Nymphalid from Tadoba National Park, and Nair (2001) added three species to the list (two Lycaenids and a Satyrid) of butterflies attracted to light from Aralam Wildlife Sanctuary, Kerala. Here we report two more species, one Lycaenid from Sanjay Gandhi National Park, Mumbai and one Papilionid from Pune, Maharashtra.

During a faunistic survey of Sanjay Gandhi National Park (located in the Mumbai-Thane suburban district in Maharashtra), at around 2330 hrs on September 26, 2001, one of us (RMS) saw a tiny butterfly fluttering and dashing against a tube light in Rest House No. 4 (Kanchan). It was identified as the Lime Blue, *Chilades laius* (Stall) Family Lycaenidae.

On April 17, 2002, at around 2000 hrs, RMS noticed a large butterfly dash against a tube light at his residence at Paul Road in Pune. Ascertaining that it was not a regular visitor, he identified it as Tailed Jay, *Papilio agamemnon* Linn. (Family Papilionidae). Incidentally, this is the first papilionid being reported as attracted to light.

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Donahue, J.P. (1962): Observations and records of Butterflies attracted to light in India. *Jour. Lepid. Soc. 16(12)*: 131-135.

Nair, V.P. (2001): Butterflies attracted to light at Aralam Wildlife Sanctuary, Kerala. *Zoo's Print Journal, 16(12)*: 670.

Sharma, R.M. & N. Chaturvedi (1999): Black Rajah *Charaxes fabius* attracted to light at Tadoba National Park. *J. Bombay Nat. Hist. Soc. 96(1)*: 168-169.

Shull, E.M. & N.T. Nadkerny (1967): Insects attracted to mercury vapour lamp in the Surat Dangs, Gujarat State. *J. Bombay Nat. Hist. Soc. 64*: 256-266.

Usman, S. (1956): Some insects attracted to light Part III. *J. Bombay Nat. Hist. Soc. 53(3)*: 482-484.

28. *FICUS PUMILA* L.: A NEW HOST PLANT OF COMMON CROW (*EUPLOEA CORE* CRAMER, LEPIDOPTERA: NYMPHALIDAE)

Common Crow *Euploea core* Cramer (Family Nymphalidae) is one of the commonest butterflies of the Indian region, virtually found in all kinds of habitats up to 2000 m above msl (Kunte 2000). The adult butterfly is a generalist species and feeds on nectar of a wide variety of plants. The larval food plants belong to families Moraceae, Asclepiadaceae and Apocynaceae; the commonly used food plants are *Ficus racemosa*, *Nerium odorum*, *N. oleander* and *Cryptolepis buchanani*.

Here I report a new host plant for the Common Crow. I found a Common Crow caterpillar feeding on Climbing Ficus (or Creeping Rubber plant *Ficus pumila,* Family Moraceae). The caterpillar was feeding on young as well as mature leaves of the ficus, showing no preference. The caterpillar successfully pupated on a nearby fern. Unfortunately, the pupa was destroyed after 10 days of pupation due to heavy rain. Climbing Ficus was introduced into India, and is now a common garden plant. It is a vine that attaches itself with its roots to walls or trees. The species is distributed in East Asia from Japan to North Vietnam.

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29. ON THE TAXONOMY AND APPEARANCE OF *MIXOLOPHIA OCHROLAUTA* WARREN (LEPIDOPTERA: GEOMETRIDAE) IN THE KUMAON HIMALAYA

Mixolophia ochrolauta Warren is a rare Emerald moth (Subfamily Geometrinae) known from a male specimen from Bhutan, which is the type, and a female from Nepal. The early stages are unknown. A single female has been recorded in Jones Estate in the Bhimtal valley of the Kumaon Himalaya, extending the known distribution of this taxon westwards. The specimen is in my collection and is described below.

***Mixolophia* Warren**

1894. *Nov. Zool*: 391.

Mixolophia ochrolauta Warren

1894. *Nov. Zool.*: 391.

Material Examined: 1 ex.: 30.ix.1977 (female).

Forewing Length: 14 mm.

Distribution: Nepal, Bhutan (Prout 1934); Bhutan (Hampson 1895).

Remarks: A new record for the Kumaon Himalaya.

According to Hampson (1895), the antennae of the male are ciliated. The antennae of the specimen examined are simple, hence it is a female. The specimen is not in perfect condition for, although the wings are intact, the scales have been rubbed off in parts, especially around the tornal area of the forewings.

The ground colour is a dull yellowish-green, agreeing with Hampson's (1895) and Prout's (1934) descriptions, but not matching the illustration in Seitz (1915), where the ground colour is a much brighter green. The specimen examined differs in another important aspect, that is the area between the postmedial line and the margin of the forewing *recto* is not striated with white above vein Cu_{1a}, as in the illustration. Hampson (1895) also noted that the veins of the outer area are white. Rather, this area is plain green with a white marginal line in the specimen examined. The specimen matches the descriptions and illustration in all other respects.

The legs of the specimen are intact and all the spurs on the hind tibiae are developed.

DISCUSSION

The specimen was recorded at the end of the SW monsoon. In subfamily Geometrinae, there are very few univoltine species in the area and it is unlikely that this is one of them. It is more likely that there is an earlier generation in spring or at the beginning of the monsoon.

Not much can be inferred about the habitat preferences of this species. It is very rare in the Bhimtal valley and the specimen recorded was probably a straggler from higher or lower elevation. It is certainly very local as well as a Himalayan endemic, but whether its rarity in collections is due to its scarcity in nature or its retiring habits will only be clarified by an understanding of its life history. It is probably commoner in biotopes that have not been thoroughly surveyed so far.

The specimen examined differs somewhat from the other two known specimens. This appears to be a case of infraspecific variation, as commonly occurs in *Episothalma robustaria* Guenée and *Spaniocentra lyra* Swinhoe of the same subfamily.

Warren (1894) and Hampson (1895) described the male, since the female was unknown at the time. Prout (1934) described both sexes. Differences between the sexes appear to be restricted to the structure of the legs and antennae.

According to Prout (1934), the hindlegs of the male type specimen are lacking. Hence, it is not possible to decide whether the species should remain in the monobasic genus *Mixolophia* or be transferred to a section of *Metallochlora* Warren. The main difference between the genera rests on the development of spurs on the hind tibiae of the male. If these are all fully developed, as in *Metallochlora*, then there is little justification for the continuance of *Mixolophia*, since the only remaining differences are details of form and colour.

Hampson (1895) placed *ochrolauta* in the genus *Hemithea* Duponchel, under the section in which the antennae of the male are ciliated and the hind tibiae lack medial spurs. Since Hampson stated that he examined the specimens of the species described in his work, and the only known specimen of *ochrolauta* at that time was the male type, it is evident that the type specimen had its hindlegs in 1895. By the time Prout examined the specimen during the 1930s, the legs were broken off, perhaps due to careless handling.

Proceeding on Hampson's (1895) statement that the male's hind tibiae lack medial spurs, it follows that *Mixolophia* differs from *Metallochlora* sufficiently to be a valid genus and that *ochrolauta* is correctly separated from *Metallochlora*.

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REFERENCES

HAMPSON, G.F. (1895): The Fauna of British India including Ceylon and Burma. Moths Vol. III. Taylor & Francis, London.

PROUT, L.B. (1934): *In*: A. Seitz (ed.) Der Gross Schmetterlinge der Erde. Die Indoaustralischen Spanner (text). Alfred Kernen, Stuttgart.

SEITZ, A. (1915): Der Gross Schmetterlinge der Erde. Die Indoaustralischen Spanner (plates). Alfred Kernen, Stuttgart.

WARREN, W. (1894): Novitates Zoologicae. London.

30. NEW RECORD OF *ALEUROCANTHUS MARTINI* DAVID, HOMOPTERA: ALEYRODIDAE, FROM INDIA

The whitefly genus *Aleurocanthus* Takahashi is represented in India by 20 species (Jesudasan and David 1991). David (1993) described *Aleurocanthus martini* David from Sri Lanka infesting *Sebastiania chamaelea* Mull-Arg. (Euphorbiaceae). In the present communication, we are reporting this species for the first time from India, breeding on 11 host plants in the Western Ghats.

***Aleurocanthus martini* David**

Aleurocanthus martini David 1993. The Whitefly of Sri Lanka. *FIPPAT Entomological Series* 3:12.

Materials examined: 5 pupal cases mounted on slides, on *Macaranga peltata,* Honnawar (Karnataka), 5.ii.2001, Coll: A.K. Dubey; 3 pupal cases mounted on slides, on *Terminalia crenulata*, Shimoga, 29.i.2001, Coll: A.K. Dubey; 10 pupal cases mounted on slides, on *Clerodendron viscosum,* Dharamsthala, 7.ii.2001, Coll: A.K. Dubey; 4 pupal cases mounted on slides, on *Homolium zeylanicum*, Unachalli falls, 19.ii.2001, Coll: A.K. Dubey; 10 pupal cases mounted on slides, on *Pterospermum diversifolium,* Unchalli falls, 19.ii.2001, Coll: A.K. Dubey; 3 pupal cases mounted on slides, on *Grewia orbiculata*, Kulum, 28.ii.2001, Coll: A.K. Dubey; 2 pupal cases mounted on slides, on *Sapindus laurifolia*, Kulem, 28.ii.2001, Coll: A.K. Dubey; 6 pupal cases mounted on slides, on *Areca catechu*, Karwar, 3.i.2001, Coll: A.K. Dubey; 3 pupal cases mounted on slides, on *Ixora* sp., Jog falls, 29.i.2001, Coll: A.K. Dubey; 1 pupal case mounted on slide, on *Tamarindus indica*, Bangalore, 21.ii.2001, Coll: A.K. Dubey; 5 pupal cases mounted on slides, on *T. grandis*, Bangalore, 17.ii.2001, Coll: A.K. Dubey.

Host range and distribution: The distribution of this species on different host plants is given in Table 1. It was found in three southern states of India, namely Goa, Karnataka and Kerala, on 11 host plants belonging to 10 families.

Table 1: Host plants of *A. martini* in Western Ghats

S. No.	Family	Host name	Distribution
1	Caesalpiniaceae	*Tamarindus indica Linn.*	Bangalore (Karnataka)
2	Combretaceae	*Terminalia crenulata* Roth.	Shimoga (Karnataka)
3	Euphorbiaceae	*Macaranga peltata* (Roxb.) Muell	Honnnawar (Karnataka)
4	Flacourtiaceae	*Homolium zeylanicum (Gardn.)* Benth.	Unachalli falls (Karnataka)
5	Palmae	*Areca catechu* Linn	Karwar (Karnataka)
6	Rubiaceae	*Ixora sp.*	Jog falls (Karnataka)
7	Sapindaceae	*Sapindus laurifolia*	Mahendragiri (Tamil Nadu)
8	Sterculiaceae	*Pterospermum diversifolium* Bl. Bijdr.	Unachalli falls (Karnataka)
9	Tiliaceae	*Grewia orbiculata* Rottl.	Kulem (Goa)
10	Verbenaceae	*Clerodendron viscosum* Vent.	Dharamsthala (Karnataka)
		Tectona grandis Linn. f.	Bangalore (Karnataka)

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REFERENCES

DAVID, B.V. (1993): The whitefly of Sri Lanka. *FIPPAT Entomological Series 3*: 12.

JESUDASAN & B.V. DAVID (1991): Taxonomic studies on Indian Aleyrodidae (Insecta: Homoptera), *Oriental Ins. 25*: 243-253.

31. NEW RECORD OF BROWN MUSSEL *PERNA INDICA* KURIAKOSE AND NAIR 1976, FROM KARNATAKA COAST

Mussels (Phylum Mollusca, Class Pelecypoda, Order Filibranchiata, Family Mytilidae) form one of the most common food sources, generally termed as poor man's food and make a sizable contribution to marine fisheries. In the past few years, in order to meet the ever-increasing demand for protein-rich nutrition, mussel culture has been taken up as a prospective

alternative to the few marine and estuarine species in mariculture. While working on the aquaculture prospects and seed resources of Green Mussel *Perna viridis* Linnaeus, an abundant species on both the west and east coasts of India, the authors came across a new mussel *Perna indica* in Amadalli, about 18 km south of Karwar in Karnataka. (Photographic evidence given –Eds).

Perna indica Kuriakose and Nair 1976 is popularly known as Brown Mussel. It has a restricted distribution along the southwest coast of India from Cape Camorin to Tiruchendur. Important centres where dense populations are found include Cape Camorin, Colachal, Muttom, Poovar, Vizhinjam, Kovalam, Varakala and Quilon. The present discovery extends its distribution northwards into the Karnataka coast. The specimens were collected from the intertidal rocky shore to shallow water up to 5-8 m depth towards leeward as well as seaward sides, attached to large expanse of rocky bed. Abundant seeds could be seen in association with *Perna viridis* and *Modiolus* sp. attached to rocks amid weeds, algae, barnacles and polychaete worm tubes. It is probable that the mussel accidentally reached this place, and established itself, as evident from the small population and isolated location. This finding is significant in view of its food value and culture prospects.

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REFERENCES

KURIAKOSE, P.S. & N.B. NAIR (1976): The genus *Perna* along the coast of India with description of a new species *Perna indica*. *Aquatic Biol.* *1*: 25-36.

32. *HYBANTHUS ENNEASPERMUS* (L.) F. MUELL — AN ADDITION TO THE WEED FLORA OF ANDAMAN & NICOBAR ISLANDS

The genus *Hybanthus* Jacq. has about 150 species distributed from tropical to sub-tropical regions of the world (Mabberley 1998). In India, it is represented by two species, namely *H. enneaspermus* (L.) F. Muell. and *H. travancoricus* (Bedd.) Melch. (Banerjee and Pramanik 1993). *H. enneaspermus,* a common weed in India, has been collected for the first time from Andamans. It forms an addition to the flora of Andaman and Nicobar Islands and a new generic record for the Islands.

For description see the references in the following citations:

Hybanthus enneaspermus (L.) F. Muell. Fragm. Phyt. Austr. 10: 81. 1976; Banerjee & Pramanik in Sharma *et al.* Fl. India 2: 343. 1993; Wadhwa & Weera sooriya in Dassanayake *et al.* Rev. Hand. Fl. Ceylon 10: 419. 1996. *Viola enneasperma* L. Sp. Pl. 2: 937. 1753.

Fl. & Fr.: September to January.

Ecology: Grows as weed near irrigation canals in wastelands and wet, open fields.

Specimen examined: INDIA. Andaman and Nicobar Islands, North Andaman, Fields near Kalpong Botanic Garden, 16.xi.2001. V.M. Radhakrishnan, 18725 (PBL).

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REFERENCES

BANERJEE, S.P. & B.B. PRAMANIK (1993): Violaceae. Pp. 343-344 *In*: Flora of India 2. Botanical Survey of India, Calcutta.

MABBERLEY, D.J. (1998): The Plant – Book (2nd edn). Cambridge University Press, Cambridge.

WADHWA, B.M. & WEERA SOORIYA (1996): Violaceae. Pp. 419-421. *In*: Revised Handbook of the Flora of Ceylon. 10. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

33. INVASION OF ALLIGATOR WEED *ALTERNANTHERA PHILOXEROIDES* (MART.) GRISEB. IN ANDAMAN ISLANDS

During a botanical exploration of the North Andaman, specimens of Alligator Weed, *Alternanthera philoxeroides* were collected. This species has not been reported from the Andaman and Nicobar Islands so far (Rao 1986; Mathew 1998). The colonization and expansion of Alligator Weed in the marshy habitats of the Andaman Islands was observed to be a threat to the indigenous flora.

Alternanthera philoxeroides (Mart.) Griseb. in Abh. Ges. Wiss. Goett. 24: 36. 1879; Maheswari in *Bull. Bot. Surv. India 6*: 313. 1965; Mishra in *J. Econ. Tax. Bot. 5*: 225. 1984; Saldanha & Rao in Saldanha Fl. Karnataka 1: 165. 1984; Raju in *Indian Bot. Reptr. 5*: 207. 1986. *Bucholzia philoxeroides* Mart., Amar. 107. 1825. (Amaranthaceae)

Perennial, aquatic or marshy, decumbent herbs. Stems fistular, longitudinally striate. Leaves lanceolate, obovate, acute to rounded, cuneate at base, 4-7 cm long. Inflorescence usually solitary, axillary pedunculate, globular head; also terminal and sessile. Tepals 5, glabrous, shining white, subequal, 1-nerved, three or four times as long as bracts. Stamens 5, united at base; pseudostaminodes distinct and extending the stamens. Ovary globose, dorsally compressed; stigma globose, capitate.

Vernacular name: Ponne.

Popular name: Alligator Weed.

Habitat: In marshes, ditches and paddy fields.

Fl. & Fr.: August-December.

Specimen examined: India, North Andaman, Diglipur: 8.xi.2001, CSReddy 2216; Radhanagar 16.xi.2001, CSReddy 2367; Mohanpur: 2.xii.2001, CSReddy 2532 (CAL & KUH).

Uses: Leaves eaten as vegetable. Tamil settlers apply warm leaf juice (after boiling in coconut oil) to blacken hair.

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REFERENCES

MATHEW, S.P. (1998): A supplementary report on the flora and vegetation of the Bay Islands, India. *J. Econ. Tax. Bot. 22*: 249-272.

RAO, M.K.V. (1986): A preliminary report on the angiosperms of Andaman-Nicobar Islands. *J. Econ. Tax. Bot. 8*: 107-185.

34. SOME INTERESTING ADDITIONS TO THE FLORA OF ANDAMAN AND NICOBAR ISLANDS FROM NORTH ANDAMAN

The Andaman and Nicobar Islands (the Bay Islands) are a group of about 350 islands and over 200 islets situated off the eastern coast of India in a junction box with Bay of Bengal and Indian Ocean on one side and South China Sea and the Pacific on the other.

The presence of over 2000 indigenous (353 endemic taxa) and 500 exotic species of flowering plants within a land area of 8,290 sq. km is a significant feature of Andaman and Nicobar Islands. The degree of endemism is about 17.6% (Reddy *et al.* 2002).

During a botanical exploration of the North Andaman Islands, we recorded nine interesting species, not recorded from Andaman and Nicobar Islands so far (Vasudeva Rao 1986; Mathew 1998). They are being reported here for the first time with a brief description. All the specimens are preserved in CAL.

Enumeration

Abildgaardia ovata (Burm.f.) Kral in Sida 4: 71. 1971. *Fimbristylis ovata* (Burm.f.) Kern, Blumea 15: 126.1967 & in Steenis, Fl. Males 7: 565. 1974. *Carex ovata* Burm.f. Fl. Indica 194. 1768. *Fimbristylis monostachyos* (L.) Hasskl. Pl. Jav. Rar. 61. 1848; FBI 6: 649. 1893; Fischer in Gamble 3: 1660 (1152). 1931. (Cyperaceae).

Stem densely tufted, 5-25 cm, slender. Leaves flat, to 15 cm, margins inrolled, to 1 mm across, scabrid, apex obtuse; ligule absent. Inflorescence with 1-2 spikelets; spikelets terete, 5-8 mm. Glumes basally distichous, apically spiral. Nut

obovoid, trigonous to 2 mm, glossy, tubercled.

Rare, weed in plains.

Fl. & Fr.: Throughout the year.

Specimen examined: North Andaman, Mohanpur: CSR 2494, 7.xii.2001.

Aristolochia indica L. Sp. Pl. 960. 1753; FBI 5: 75. 1886; Gamble 2: 1202(841). 1925.

Twining shrubs to 4 m. Leaves very variable, oblong to oblong obovate 2-6 x 1-3 cm, 3 nerved from base, lateral nerves 3-4, converging towards apex, base truncate to subcordate or panduriform, apex obtuse to acuminate. Racemes axillary or terminal to 3 cm, 8-15 flowered, dark purple limb 1-lipped, rolled back. Capsule 4 x 2 cm; seeds oblong, 5 mm obtuse, laterally winged.

Rare in hedges and open forests on fences.

Fl. & Fr.: October-April.

Specimen examined: North Andaman, Mohanpur: CSR 2501, 8.xii.2001.

Dinebra retroflexa (Vahl) Panz. in Denkschr. Acad. Viss. Munchan. 270. t. 12. 1814; Fischer in Gamble 3: 1841 (1274). 1934. *Cynosurus retroflexus* Vahl Symb. Bot. 2.20. 1791. (Poaceae).

Annual. Culms tufted, up to 70 cm tall. Leaves 5-10 x 0.2-0.4 cm, linear, base cordate, apex acuminate. Spikes racemosely arranged along the axis, up to 20 cm long. Spikelets 5 mm, 2-flowered. Caryopsis ellipsoid-oblong.

Common weed.

Fl. & Fr.: July-September.

Specimen examined: North Andaman, Shyamnagar: CSR 2791, 27.xii.2001.

Ficus mollis Vahl, Bot. 1: 82. 1790. *F. tomentosa* Roxb. ex. Willd Sp. Pl. 4: 1136. 1806; FBI 5: 501. 1888; Fischer in Gamble 3: 1361 (952). 1928.

Trees with rusty foliage, branchlets fulvous-tomentose. Leaves spiral or subopposite, elliptic-ovate to panchurate, 6-15 x 3-8 cm, dark green above, yellow-fluffy below, subcoriaceous, 3-nerved from base, lateral nerves 5-7 pairs, impressed above, raised below. Figs monoecious, axillary, paired or clustered, sessile, globose, 0.5-0.8 cm across. Achenes smooth.

Occasional in forests.

Fl. & Fr.: July-December.

Specimen examined: North Andaman, Kafeedera: CSR 2517, 22.xi.2001.

Lindernia ciliata (Colsm.) Pennell, Brittonia 2: 182.1936. *Gratiola ciliata* Colsm. Prodr. Desr. Gratiol. 14.1793. *Hysanthes serrata* (Roxb.) Urban, Ber. Dentsch. Bot. Ges. 2: 436.1884. Gamble 2: 962 (675). 1923.

Erect herbs. Leaves elliptic-obovate, 2-3.5 x 0.5-1 cm, penninerved, base cuneate, aristate, dentate, apex acute to obtuse. Flowers in terminal racemes. Corolla white with pink throat. Capsule linear lanceolate, 1.5 cm, exceeding the calyx.

Common in forests.

Fl. & Fr.: October-February.

Specimen examined: North Andaman, Swarajgram: CSR 2393, 13.xi.2001.

Nicotiana plumbaginifolia Viv. Elench. Pl. Hort. Bot. 26.t.15. 1802; FBI 4: 242. 1883.

Erect viscid, annual herbs to 75 cm tall. Stems simple or branched from the base, glandular-hairy. Basal leaves in a rosette, obovate, 5-15 cm, cauline ones sessile, obovate, smaller, passing into bracts, all leaves undulate-crispy, glandular. Flowers in cymose, leafy panicles. Calyx 10-ribbed, glandular-hairy, lobes unequal, lanceolate-subulate, 0.5-0.7 cm long. Corolla rosy or greenish-white, glandular hairy outside, 2.5-3 cm long, lobes ovate, obtuse. Fruit 0.8-1 cm long. Seeds rugose.

Rare weed of riverbanks and gardens.

Fl. & Fr.: March-November.

Specimen examined: North Andaman, Diglipur: CSR 2536, 28.xi.2001.

Phyllanthus maderaspatensis L. Sp. Pl. 982.1753; FBI 5: 292. 1887; Gamble 2: 1289 (902). 1925.

Erect herb, to 70 cm. Leaves linear to obovate, 0.7-2 x 0.3-0.7 cm, glaucous below, base cuneate, apex retuse or obtuse. Male flowers above and female flowers below. Capsule 3-valved, globose, 4 mm across, 3-lobed; seed triquetrous, muriculate.

Rare weed of dried up paddy fields.

Fl. & Fr.: Throughout the year.

Specimen examined: North Andaman, Diglipur: CSR 2539, 28.xi.2001.

Pergularia daemia (Forssk.) Chiov. Result. Sco. Miss. Stetan. Paoli sonal. Ital. 1: 115.1916. *Asclepias daemia* Forssk. Fl. Aesypt – Arab 51.1775. *Pergularia extensa* (Jacq.) N.E. Br. in Thistleton – Dyer. Fl. cop. 4: 758.1908; Gamble 2: 836(589) 1923.

Straggler with foetid smell. Leaves cordiform, 2-6 x 2-8 cm, thick chartaceous, base cordate, lobes intricate, apex acute. Raceme umbelliform, axillary, corolla greenish. Follicles sticky, curved, basally swollen, obtuse.

Rare in open semi-evergreen forests.

Fl. & Fr.: November-April.

Specimen examined: North Andaman, Entrance Island: CSR 2689, 12.xii.2001.

Polygonum plebeium R. Br. Prodr. 420.1810, FBI 5: 27.1886; Gamble 2: 1188 (832) 1925. *P. indicum* Heyne ex. Roth Nov. Pl. Sp. 208.1821.

Prostrate herb. Ochreae tubular, 2 mm hyaline. Leaves

spiral, oblong 0.5-0.8 x 0.1-0.3 cm, thick; mid-nerve impressed above, prominent below, lateral nerves obscure, base attenuate, apex obtuse or acute, subsessile. Flowers hermaphrodite, in axillary fascicles. Perianth rose. Nutlets strongly trigonous, with persistent style.

Common weed of marshy places.

Fl. & Fr.: November-April.

Specimen examined: North Andaman, Mohanpur: CSR 2505, 8.xii.2001.

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REFERENCES

VASUDEVA RAO, M.K. (1986): A preliminary report on the angiosperms of Andaman-Nicobar Islands. *J. Econ. Tax. Bot. 8*: 107-185.

MATHEW, S.P. (1998): A supplementary report on the flora and vegetation of the Bay Islands, India. *J. Econ. Tax. Bot. 22*: 249-272.

REDDY, C.S., P.R.C. PRASAD, M.S.R. MURTHY & C.B.S. DUTT (IN PRESS): Census of endemic flowering plants of Andaman and Nicobar Islands, India. *J. Econ. Tax. Bot.*

35. *DENDROPHTHOE FALCATA* (L.F.) ETTING. ON *COMMIPHORA WIGHTII* (ARN.) BHAND.: A NEW RECORD OF PARASITIC ASSOCIATION

Dendrophthoe falcata (L.f.) Etting. (Family Loranthaceae) has attracted more attention from plant scientists than any other flowering plant parasite for documentation of host range. Fischer (1926) systematically recorded 153 host plants of this partial stem parasite from southern parts of India. Since then, many enumerators have reported new hosts from time to time and eventually Fischer's list has been increased to 410. Hawksworth *et al.* (1993) presented a comprehensive list of recorded hosts for *D. falcata*. A scrutiny of the literature reveals that parasitism of *D. falcata* on *Commiphora wightii* (Arnott) Bhandari (Family Burseraceae) has not been recorded by any of the earlier enumerators; hence we record it here for the first time. *Boswellia serrata* Roxb., syn. *Commiphora gileadense* (Roxb.) Almeida, *C. caudata* (W. & A.) Engl., *C. pubescens* (W. & A.) Engl. and *Garuga pinnata* Roxb. are the 5 other known hosts from Family Burseraceae.

On a visit to a herbal garden developed by Anoopam Mission, a socio-religious institution, located at Mogri village, near Anand, in central Gujarat, the senior author noted a few individuals of this common parasite growing on a guggul (*Commiphora wightii*) tree, which is of medicinal importance (Photographic evidence provided by the author – Eds).

If *D. falcata* establishes its parasitic relationship with *C. wightii*, there will be added pressure on this economically important host, which is presently endangered due to over exploitation and improper methods of extracting the oleoresin. Constant monitoring of the natural populations of *C. wightii* is recommended as a preventive measure.

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REFERENCES

FISCHER, C.E.C. (1926): Loranthaceae of southern Indian and their host plants. *Rec. Bot. Surv. India 11*: 159-195.

HAWKSWORTH, F.G., Y.P.S. PUNDIR, C.G. SHAW & B.W. GEILS (1993): The host range of *Dendrophthoe falcata* (L.f.) Etting. (Loranthaceae). *Indian J. Forestry 16*: 263-281.

36. FIRST RECORD OF *CLATHRUS DELICATUS* BERKELEY & BROOME 1873 FROM SANJAY GANDHI NATIONAL PARK, MUMBAI

In the monsoon of July 1996, during a survey on Owl moths (*Othreis* spp.), I came across a small shuttlecock-shaped fungus growing among the rocks, in the wooded areas of Sanjay Gandhi National Park (SGNP) in Mumbai, Maharashtra State, India. I could not identify it, but sent colour photographs to the Smithsonian Institution, USA for identification. The photographs were then forwarded to Dr. David Farr at the National Fungus Collection in Beltsville,

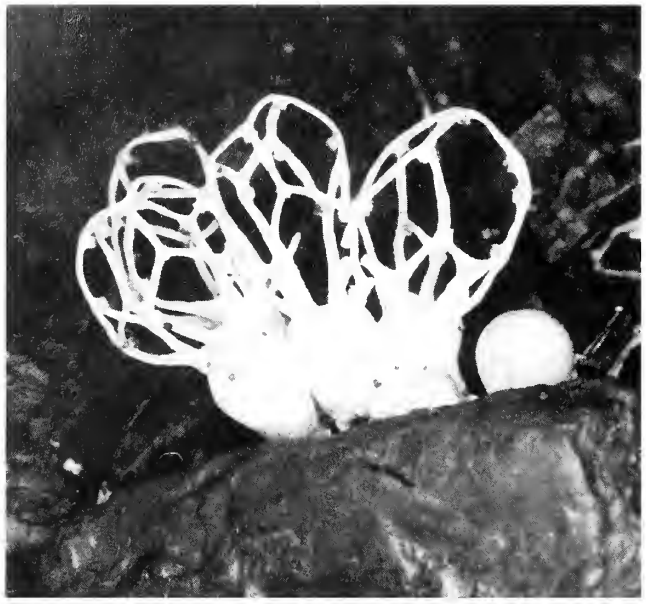

Fig. 1: A large fruiting colony of *Clathrus delicatus*

Maryland, USA, who sent them to Dr. Orson Miller Jr. at Virginia Tech University for identification. Finally, on May 14, 1998, Dr. Miller identified the fungus as *Clathrus delicatus* Berkeley & Broome, a rare species described from Sri Lanka (Berkeley and Broome 1875). Dr. Miller also advised me to collect fresh specimens and dry them for detailed examination. In 2000, we studied the specimens in his laboratory and confirmed that they were *Clathrus delicatus*. This is the second record in India and that too after 64 years. The only record of this species in India is from Mysore in 1932 by Narasimhan. The description of the specimen matches with that of Dring (1980); Petch (1908) and Fischer (1890-1900).

In 1997 and 1998, all my efforts to locate the fungus failed. However, in 1999, I managed to locate a large fruiting colony on a pile of rotting bamboo logs, from which I collected specimens, including the matured receptacle and buds (Fig. 1). Some specimens were also preserved in 70% formaldehyde. I also managed to collect the insects, which seem to be responsible for fertilisation of this fungus, the species of which could not be identified.

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REFERENCES

Berkeley Rev. M.J. E.L.S. & C.E. Broome, Esq, F.L.S. (1875): Enumeration of the Fungi of Ceylon. Part II, containing the remainder of the Hymenomycetes, with the remaining established tribes of Fungi. *Journ. Linnaean Soc., London, Botany XIV*: 29-139.

Dring, D.M. (1980): Contributions towards a rational arrangement of the Clathraceae. *Kew Bull. 35(1)*: 1-96.

Fischer, Ed. (1890-1990): Untersuchungen zur Vergleichenden Entwicklungsgeschichte und Systematik der Phalloideen, Mit 6 Tafeln und mehreren Holzschnittenetch.

Narasimhan, M.J. (1932): The Phalloideae of Mysore. *Journ. Indian Botanical Survey 11*: 248-254.

Petch, T. (1908): The Phalloideae of Ceylon. *Ann. Roy. Bot. Gard. Peradeniya 4(4)*: 139-182.

37. STUDIES ON THE SEASONAL ASPECTS OF ANGIOSPERMIC WALL VEGETATION OF KHARGONE AND ITS SUBURBS

Our knowledge of the wall flora is limited both at national and international levels (Willis *et al.* 1893; Salisbury 1920; Fitter 1945; Rishbeth 1948; Ghosh 1960 and Varshney 1971). Earlier the flora of this tract has been studied by Shastri (1977), but no information on the wall flora of this area is available till date. Wall vegetation may serve as basic knowledge for artificial habitats (Sahu 1984); hence the present communication attempts to study the wall vegetation of Khargone and its suburbs in different seasons of the year.

Khargone city (21° 45' N, 75° 30' E; 250.38 m above msl) is headquarter of the West Nimar district of Madhya Pradesh. It is one of the tribal districts of the state, and more than 30 percent of the population belongs to tribal communities (Bhilala, Korki, Manka and Barela). Biogeographically it is a part of central India. This area enjoys a variety of habitat conditions and is also thickly populated. In the past three

decades, a number of colonies have been developed around the city. There are a number of temples, mosques, old buildings and an old fort wall in dilapidated condition along the bank of River Kunda, a tributary of Narmada. Besides, there are a large number of huts made up of mud and bricks on both sides of the river near Bhatwadi area and the newly formed Sanjay Nagar. Wall habitats – mud walls, brick mud wall, brick mortar wall – roofing of earthen tiles, old buildings, temples and mosques provide a unique habitat for the development of a specialised "wall flora" (Sahu 1984).

Method of study: In order to study the wall flora, plants growing on old buildings, temples, terraces, boundary wall, mud wall, brick mud wall, brick mortar wall, dug well boundary wall, fort wall, roofs of earthen tiles, and crevices of cemented walls were collected during June 1997 to May 1998 and identified after consulting standard literature (Duthie 1952; Cooke 1957; Willis 1973). Herbarium sheets were prepared and deposited in the Botany Department, Govt. Post Graduate College, Khargone for record. Meteorological data were obtained from the Jawaharlal Nehru Krishi Vishwavidyalaya, Research Centre, Khargone (Table 1). The plants obtained during the survey are enumerated alphabetically in Table 2, the dominant families are listed in Table 3.

Climate: The climate of Khargone is typically monsoonic and shows three different seasons in a year i.e. monsoon, winter and summer. June is the transitional month between summer and monsoon, while October is the transitional month between monsoon and winter. The total average annual rainfall for the period under investigation is 663 mm. The maximum rainfall (201.50 mm) was recorded in July 1997, while maximum number of rainy days was recorded in August 1997. The rainfall is irregular and uneven, and about 80 to 90 percent is recorded during June to September. A few mid showers are recorded in winter. The mean minimum (11.2 °C) and maximum temperatures (45.2 °C) were recorded in February 1998 and May 1998 respectively. The average relative humidity ranges from 68.0 to 94.5 percent, which was maximum in July, 1997. There are 7 wet months and 5 dry months in the year.

Table 1: Climatological data of Khargone from June, 1997 to May, 1998

Year and months	Rainfall (mm)	Rainy days	Temperature Mean max.	Temperature Mean mini.	Relative Humidity (mean %)
1997					
June	153.0	7	31.1	23.7	84.7
July	201.5	10	31.5	26.1	86.5
August	143.0	11	29.8	25.1	85.5
September	77.5	5	30.5	24.6	79.0
October	11.5	2	31.0	23.2	74.3
November	26.0	2	23.0	19.9	78.9
December	50.5	4	29.7	14.0	80.1
1998					
January	—	—	29.6	12.0	75.0
February	—	—	34.4	11.2	63.4
March	—	—	42.1	13.2	54.2
April	—	—	43.5	19.7	45.5
May	—	—	45.2	27.1	35.4
	663.0	41			

Table 3: Dominant families in the wall flora of Khargone

Family	Number of genera	Number of species
Poaceae	12	12
Asteraceae	10	10
Euphorbiaceae	3	7

Observations and Discussions: The wall flora of man-made habitats of Khargone and its neighbourhood areas has 61 angiosperm species belonging to 56 genera and 24 families (Table 2). A number of lower cryptogamic plants namely algae, mosses among others were also seen on such habitats, but have not been included in the present study. The plant species on the wall habitats varies considerably with respect to different seasons of the year. In early July, at the onset of monsoon, many plant species like *Achyranthes aspera, A. spinosus, Cynodon dactylon, Cyperus rotundus, Euphorbia hirta, Phyllanthus fraternus* etc. appeared on the walls. During late July and August, when the number of rainy days are maximum, plants such as *Ageratum conizoides, Boerhaavia diffusa, Commelina benghalensis, Euphorbia* sp., *Tridax procumbens, Vernonia cineria, Sonchus asper* and many grasses show luxuriant growth. This may be due to a high percentage of relative humidity during monsoon. Most of these species disappear after the rains, but on account of frequent rainfall during winter from November to December; plants like *Ageratum conizoides, Tridax procumbens, Vernonia cinerea* and some other herbaceous annuals show luxuriant growth on wall habitats and continue to grow with woody perennials like *Ficus religiosa.*

The wall vegetation becomes extremely thin and sparse during summer and is represented by plants like *Amaranthus spinosus, Ficus religiosa* and *Tridax procumbens.* When the temperatures soar in May (max. 45.2 °C) almost all the vegetations on man-made habitats die except for a few woody perennials. The constituent elements of the wall flora include species belonging to 20 families and the most dominant families are Poaceae (12 spp.), Euphorbiaceae (10 spp.) and Asteraceae (7 spp.) (Table 3).

The wall vegetation varies with the type of wall, e.g. walls made using black-cotton soil exhibit species like *Brassica campestris, Echinochloa colonum* etc. which are characteristic features of dry pond vegetation. It is possible

Table 2: Enumeration of plants observed on the walls of old buildings of Khargone and its neighbouring areas

Species	Family	Season	Life form
Achyranthes aspera Linn.	Amaranthaceae	R	Th
Ageratum conizoides Linn.	Asteraceae	R, W	Th
Alysicarpus monilifer DC.	Fabaceae	R, W	Th
Amaranthus spinosus Linn.	Amaranthaceae	R,W,S	Th
A. viridis Linn.	Amaranthaceae	R,W	Th
Andrographis paniculata Nees.	Acanthaceae	R	Th
Aristida depressa Retz.	Poaceae	R	Th
Aristolochia bracteata Lamk.	Aristolochiaceae	R ,W,S	Ch
Azadirachta indica A. Juss.	Meliaceae	R,W,S	Ph
Boerhaavia diffusa Linn.	Nyctaginaceae	R,W,S	Ch
Brachiaria distachiya (Linn.) Stapf.	Poaceae	R	Th
Brassica campestris Linn.	Brassicaceae	R, W	Th
Calotropis procera (Aito.) R. Br.	Asclepiadaceae	R,W,S	Ph
Carica papaya Linn.	Caricaceae	R,W,	Ph
Carthamus oxycanthus Linn.	Asteraceae	R	Th
Cassia tora Linn.	Fabaceae	R	Th
Celosia argentea Linn.	Amaranthaceae	R	Th
Cenchrus ciliaris Linn.	Poaceae	R	Th
Chloris barbata SW.	Poaceae	R	Th
Cnicus arvensis Linn.	Asteraceae	R	Th
Commelina benaghalensis Linn.	Commelinaceae	R	Th
Chrozophora rottleri A. Juss.	Euphorbiaceae	R,W,S	Ch
Cyathocline purpurea (Don.) Kuntz.	Asteraceae	R,W,S	Th
Cynodon dactylon Pers.	Poaceae	R	Th
Cyperus rotundus Linn.	Cyperaceae	R	Th
Dactyloctenium aegypticum Unn.	Poaceae	R	Th
Echinochloa colonum (Linn.) Link.	Poaceae	R	Th
Euphorbia geniculata Orgeg.	Euphorbiaceae	R	Th
E. hirta Linn.	Euphorbiaceae	R, W	Th
E. microphylla Heyne	Euphorbiaceae	R	Th
E. prostrata Ait.	Euphorbiaceae	R	Th
E. thymifolia Wall.	Euphorbiaceae	R	Th
Ficus religiosa Linn.	Moraceae	R,W,S	Ph
Heliotropium supinum Linn.	Boraginaceae	R	Th
Impatiens balsamina Linn.	Balsaminaceae	R	Th
Ipomoea obscura Ker.Gawl.	Convolvulaceae	R	Th
Ischaemum rugosum Salisb.	Poaceae	R	Th
Launaea asplenifolia DC.	Asteraceae	R	Th
Malvastrum tricuspidatum A. Gray	Malvaceae	R,W	Th
Merremia emarginata (Burm.f.) Hall. f.	Convolvulaceae	R,W	Ch
Millingtonia hortensis L.F.	Begnoniaceae	R,W,S	Ph
Momordica charantia Linn.	Cucurbitaceae	R,W	Th
Oropetium thermaceum Linn.	Poaceae	R	Th
Parthenium hysterophorus Linn.	Asteraceae	R,W,S	Th
Peristrophe bicalyculata (Retz.) Nees.	Acanthaceae	R,W	Th
Physalis minima Linn.	Solanaceae	R	Th
Phyllathus niruri Linn.	Euphorbiaceae	R	Th
Portulaca oleracea Linn.	Portulacaceae	R	Th
Rhoeo discolor Hance	Commelinaceae	R	Ch
Ruellia tuberosa Linn.	Acanthaceae	R	Th
Setaria glauca (Linp.) P. Beauv.	Poaceae	R	Th
Sida cordifolia Linn.	Malvaceae	R	Th
Sonchus asper Vill.	Asteraceae	R	Th
Sporobolus diander (Retz.) P. Beauv.	Poaceae	R	Th
Taraxacum officinale Linn.	Asteraceae	R	Th
Themeda triandra Forsk.	Poaceae	R,W,S	Th
Trianthema portulacastrum Linn.	Aizoaceae	R,W,S	Ch
Tribulus terrestria Linn.	Zygophyllaceae	R,W	Ch
Tridax procumbens Linn.	Asteraceae	R,W,S	Th
Veronia cinerea (Linn.) Less.	Asteraceae	R,W	Th
Zornia diphylla (Linn.) Pers.	Fabaceae	R,W	Th

R = Rainy; W = Winter; S = Summer; Th = Therophytes; Ch = Chamaephytes; Ph = Phanerophytes.

that seeds of these species are brought along with the mud and dung used for plastering these mud walls.

In walls made-up of alluvial red soil and bricks, the substratum remains free from water-logging. When these wall layers are gradually exposed due to run-off water, the free soil particles are washed away. The most common species reported on such walls are *Tridax procumbens* and a few grasses. When the brick walls are made from a mixture of slacked lime and sand, it becomes recarbonated by absorbing atmospheric CO_2 and turns into an artificial lime stone. Such walls are found in old and weathered buildings, Here too, the wall vegetation is similar to brick mud walls and shows characteristic xerophytic annual greens, but plants like *Apluda mutica* and *Trianthema portulacastrum* are reported only on brick mortar walls.

The plant species found on man-made habitats show stunted growth as compared to their terrestrial counterparts e.g. *Ficus religiosa* and *Vernonia cinerea* are shorter, while plants such as *Ageratum conizoides*, *Carica papaya* show reduced leaves. The poor growth of these plants may be correlated to their extremely reduced root system, which has been observed by earlier workers like Rishbeth (1948). The growth of the wall vegetation is influenced by some edaphic and biological factors, and among this human interference is one of the most dominating factors. This can be regarded as a part of the environmental complex in relation to which wall vegetation has developed because repairing of old walls, changes in construction of houses are factors due to which the wall flora is destroyed and changed. In 1967, Varshney correlated the climatic fluctuations with the seasonal aspects of wall vegetation. In most cases, the seeds are carried to the walls with the help of wind. In wind-pollinated species, seeds are numerous, small, smooth and light. Members of Family Asteraceae possess parachute mechanism for their fruit dispersal while seeds of *Achyranthus aspera* have appendages for cohesion, adherence or sticking. Birds play an important role in seed dispersal of fleshy fruits like *Carica papaya* and *Ficus* spp. Some weeds are also dispersed by birds in making nests on the recesses of walls and buildings. Human agency also plays a role in seed dispersal of plants like *Brassica campestris* and others.

Thus, a variety of plant species are included in wall vegetation such as trees, weeds, cultivated plants, common grasses, roadside garden escapes etc. According to Raunkiaers' life forms, the wall vegetation of Khargone shows a marked contrast from the ground flora in exhibiting a high percentage (85.72%) of therophytes and this may be correlated with the climatic conditions of the study area. Phanerophytes, Geophytes and Chamaephytes are represented by 8.16%, 2.04% and 4.08% respectively. No Hemicryptophytes were observed on the Khargone wall flora. Rishbeth (1948), however, has observed a higher percentage of Hemicryptophytes on Cambridge walls, which may be correlated with the difference in climatic conditions. The present study supports the observations made by Sahu (1984). One interesting case of *T. portulacastrum* is worth mentioning. This species exhibits green and red forms which possess different abilities to exploit soils rich in nitrogenous compounds and are nitrophilous, but the green form occurring on brick mortar wall has been found to accumulate more nitrogen than the red form, hence they may be called as 'eurynitrine' and 'stenonitrine' respectively as recently suggested by Crawford (1989).

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REFERENCES

Cooke, T. (1957): The Flora of the Presidency of Bombay. Vol. I & II. Adlard & Sons Ltd., London. BSI Reprint, Calcutta.

Crawford, R.M.M. (1989): Studies in Plant Survival: Ecological case histories of plant adaptation to adversity. Blackwell Scientific Publications, Oxford, London, Edinburgh. 446 pp.

Duthie, J.F. (1952): Flora of the Upper Gangetic Plain and of the adjacent Siwalik and Sub-Himalayan tracts, 1903-22. Vol I-III, Government of India, Central Publication Branch, Calcutta.

Fitter, R.S.R. (1945): London's Natural History. Collins, London. 284 pp.

Ghosh, R.B. (1960): Preliminary observations on the flora of dilapidated walls and buildings of Calcutta and suburbs. *J. Indian bot. Soc. 29*: 548-557.

Rishbeth, J. (1948): The flora of Cambridge wall. *J. Ecol. 36*: 136-148.

Sahu, T.R. (1984): Studies of the wall flora of man-made habitats of Sagar. *Indian J. Forest. 7(3)*: 232-238.

Salisbury, E.J. (1920): The significance calcicolous habit. *J. Ecol. 8*: 202-215.

Shastri, M.B. (1977): Flora of Khargone, Madhya Pradesh. Recent Trends and Contacts between Cytogenetics, Embryology and Morphology. Nagpur University, pp. 445-454.

Varshney, C.K. (1971): Observation on the Varanasi wall flora. *Vegetatio 22*: 355-372.

Willis, J.C. (1973): A Dictionary of the Flowering Plants and Ferns, 8th ed. (revised by H.K. Airy Shaw), Cambridge University Press, London. 1245 pp.

Willis, J.C. & I.H. Burkill (1893): Observation on the flora of the Pollard Willows near Cambridge. *Proc. Camb. Phil. Soc. 8*: 82.

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